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The Engineer

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EF INSPECTOR REQUIRED. Applicants must be qualified Mechanical Engineers and held similar position and have thorough ence in Organisation of Patrol Inspection ver production of important engineering engaged on medium-size products for t and post-war requirements. Midland —Applicants should write to MINISTRY LABOUR AND NATIONAL SERVICE, ndra House, Kingsway, London, W.C.2, e necessary forms of application; the ce number C.1692 X must be quoted. 9987 A

The Engineer

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SITUATIONS OPEN

TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

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Advertisers in Situations Open Column should make themselves acquainted with the terms of

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Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of THE ENGINEER.

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SITUATIONS OPEN

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For continuation of Small Adver ments see page 4

THE ENGINEER

A Seven-Day Journal

The British Employers' Confederation

AN announcement by the British Employers' Confederation states that Lord Weir of Eastwood has been re-elected to the post of Honorary President of the Confederation for the ensuing year, while Sir Harry F. Brand has been re-elected President. The two Vice-Presidents (Sir Charles Craven and Mr. Andrew K. M'Cosh) have also been re-elected, and they are joined by Mr. Allan C. Macdiarmid. On Saturday, June 26th, while speaking at Braintree, Mr. Tom Driberg stated that Sir Andrew Duncan, the Minister of Supply, had been invited to become the Director-General of a new organisation to be set up by the Federation of British Industries and the British Employers' Confederation. On Monday this statement was the subject of a disclaimer issued by the Ministry of Supply, on behalf of Sir Andrew Duncan. Sir Harry F. Brand, the President of the Confederation, has also denied the statement made by Mr. Driberg, and has revealed that for some time past efforts have been made to secure for the employers after the war a body which would speak with one voice, in a similar way to that in which the labour interests are represented by the Trades Union Council. While unity of action is being sought for at the present time by the Federation of British Industries and the British Employers' Confederation, the further possibility of a joint body of employers and the T.U.C. co-operating with the Government in the working out of plans for the post-war period has, it is stated, not been overlooked.

Rubber Tyre Economy

WHEN opening the Tyre Economy Exhibition at 129, Deansgate, Manchester, on Thursday, June 24th, Lord Rothes, Director of Tyres, referred to the critical position of our rubber supplies and stressed the importance of practising economy of rubber usage. Regarding synthetic rubber, he indicated, first, that large supplies are not immediately available, and, secondly, that even when they arrive in quantity, we shall want to have the largest possible stock of natural crude rubber left, as some things, notably the casings of giant tyres, cannot be made satisfactorily from synthetic rubber. As tyres consume about 70 per cent. of the rubber we use, they offer the largest field in which economy can be effected. There were, he said, three chief ways of effecting tyre economy. First, the quantity of rubber used in tyres may be reduced, and other materials substituted without debasing the quality of the tyre below the economic level. Thanks to the prompt and whole-hearted co-operation of the tyre manufacturers, maximum economy has already been effected along this line, and a saving of 5000 tons of rubber per year has been achieved on civilian tyres alone. Secondly, economy in tyres can be achieved by ensuring that only those people entitled to obtain tyres in wartime receive them. That economy, too, was being successfully accomplished. The planning of civilian production and the tyre-rationing scheme had saved not less than 9000 tons of rubber during the past year. Thirdly, economy can be effected by the tyre users. Only one out of three covers at present returned was fit for retreading. That proportion was higher than it was some months ago, but was still far too low; and as from some of the best-maintained fleets of vehicles the proportion is seven out of ten, it was clear that improvement is easily possible. If the average of covers fit for retreading could be raised from one in three to seven in ten, the saving in rubber would be at least 4000 tons per year. There were in this country, Lord Rothes said, more than 50,000 tons of rubber in the form of tyres on civilian vehicles. A sound carcase could be retreaded and made fit for further service by the expenditure of at the most 50 per cent. of the rubber necessary to manufacture a new tyre of the same size. If each civilian vehicle user in this country could use the rubber equivalent of one fewer tyre per vehicle per year, 10,000 tons of rubber would be saved.

British Internal Combustion Engine Research Association

THE British Internal Combustion Engine Research Association, which was recently incorporated, has now completed its organisation. Viscount Falmouth, M.I. Mech. E., has accepted the position of President of the Association, and Engineer Vice-Admiral F. R. G. Turner (Engineer-in-Chief of the Fleet), Major-General J. S. Crawford, M.I. Mech. E. (Director of Mechanisation, Ministry of Supply), and Dr. S. F. Dorey, M. Inst. C.E., M.I. Mech. E. (Chief Engineer Surveyor of Lloyd's Register of Shipping) have accepted the position of Vice-Presidents. Mr. Charles Day, M.I. Mech. E. (a Past-President of the Institution of Mechanical Engineers), has been elected Chairman of the Council, on which the Department of Scientific and Industrial Research will be represented. A Research Committee has been appointed by the Council, consisting of Mr. Charles Day (Mirrlees, Bickerton and Day), Mr. H. S. Aspinall (English Electric Company), Mr. Desmond Carter (Crossley Brothers), Mr. C. B. M. Dale (Brush Electrical Engineering Company), Mr. J. Jones (National Gas and Oil Engine Company), Mr. R. B. Lister (R. A. Lister and Co.), Mr. H. E. Muckley (Belliss and Morcom), Mr. E. P. Paxman (Davey, Paxman and Co.), Mr. H. Richardson (F. Perkins), and Mr. O. Wans (Ruston and Hornsby). Invitations to join this Committee have been extended to Commander Hall (Admiralty Engineering Laboratory), Mr. G. H. Forsyth (of Lloyd's Register of Shipping), and to the Department of Scientific and Industrial Research to appoint a representative. Messrs. Deloitte, Plender, Griffiths and Co. have been appointed auditors to the Association, and Mr. H. Cowper, F.C.I.S., its secretary; the association's office will be at 32, Victoria Street, London, S.W.1.

Retirement of Professor C. E. Inglis

IT can now be said definitely that Professor C. E. Inglis, who for so many years has held with distinction the post of Professor of Mechanical Sciences in the University of Cambridge, is retiring, having already passed the age limit. Professor Inglis was educated at Cheltenham and King's College, Cambridge (Scholar). He was twenty-second Wrangler and First-class Mechanical Science Tripos. For some time he acted as assistant to Sir John Wolfe Barry, and in 1901 became assistant in the Engineering School at Cambridge under the late Sir J. A. Ewing. He subsequently was appointed University Lecturer in Engineering. In 1924 he was awarded the Telford Medal by the Institution of Civil Engineers. During the last war Professor Inglis served in the R.E. as Bt. Major, and was the inventor of bridges which were used during the war. In 1919 he was elected to the Chair of Mechanical Engineering, and at once started to reorganise the Engineering School, the new buildings of which were opened some five years later. A full account of the laboratory and engineering education at Cambridge will be found in THE ENGINEER of October, 1924. Last week Lord Brabazon of Tara paid a warm tribute to the teaching capacity of Professor Inglis, a tribute which is echoed by a whole generation of students at Cambridge. Alongside his University work, Professor Inglis found time to interest himself in many scientific societies and institutions, and he has done good work for the Institution of Civil Engineers (of which he is Past-President), the Institution of Naval Architects, the Institution of Structural Engineers, the Institution of Municipal and County Engineers, and the British Waterworks Association. He will be succeeded at Cambridge by Professor J. F. Baker, who has held the Chair of Civil Engineering at the University of Bristol since 1933. He was educated at Rossal School and Clare College, Cambridge (Scholar), and in 1925 became Technical Assistant in the Design Department of the Royal Airship Works at Cardington. He was a Lecturer at the Cardiff University College in 1926, and in 1928 was appointed scientific assistant at the Building Research Station. From 1931 to 1936 he was technical officer to the Steel Structures Research Committee. He is an associate member of the Institution of Civil Engineers and holder of the Telford Premium and the Howard Quinquennial Medal and Prize. Since 1939 he has been a member of the Civil Defence Research Committee.

Torpedoed Merchant Ships Reach Port

SINCE the war began our merchant shipyards have been busy in their repair departments, making damaged merchant ships ready for sea once again. The bringing of such ships safely to harbour often entails arduous work by officers and crews, and in many cases the repairs which have been successfully carried out have borne witness to the reliable and sturdy construction of our merchant ships. Quite recently the Ministry of War Transport released accounts of three merchant ships which after torpedo damage were brought to port. The motorship "British Merit" was hit by a torpedo in her engine room at 11 a.m., only seven days after leaving a United Kingdom port. Of the two men on duty in the engine room, one was rescued by Mr. C. Craggs, the chief engineer, and the other died. The ship was helpless in a heavy sea, but the master, Captain E. G. Dobson, refused to abandon her. The damage was got under control and eight days later the ship was towed into harbour. In the case of the motorship "British Renown" the vessel received a forward hit at 1 a.m., began to settle down by the head, and was unable to maintain her position as leader of a line in the convoy. At daybreak the convoy was out of sight, but with a hole measuring 42ft. by 30ft. in the bows of his ship, Captain J. M. Georgeson, the master, was able to overtake the convoy and resume his station. The motorship "Stadella" (master, Captain J. M. Lyon) received a torpedo hit amidships, and with even more damage was obliged to drop astern. With one hold damaged, the "Stadella" was later able to rejoin her convoy, and in her damaged condition she continued her voyage of 400 miles, and successfully landed the remainder of her cargo of oil at a port in the United Kingdom.

Engineers and the British Empire

By Professor MIDDLETON SMITH, M.Sc., M.I. Mech. E., LL.D.

No. I

Introduction

DURING visits to many parts of the British Empire my chief interests were the inspection of engineering works and discussions with British engineers responsible for them. In many cases difficult problems had been solved, some connected with technology, others caused by the vagaries of human nature. Engineers had often, it was obvious, worked under very trying conditions of climate, labour, and equipment.

On long voyages, train journeys across continents, and extended visits to towns, districts, &c., there were opportunities to meet engineers from other parts of the Empire. They told me of their experiences in tropical lands and other out-of-the-way places of the earth.

A residence of twenty-seven years in the Far East and the long university vacations enabled me to visit many places in Eastern Asia and to compare engineering progress in Japan, China, Indo-China, Siam, and the Dutch East Indies, with that made in the overseas portions of the British Empire. My final impression is that there is no reason to be ashamed of the enterprise and ability of British engineers overseas; nor is the comparison of the general results of British administration, public health services, labour supervision, and the contentment of natives unfavourable to British officials and British residents overseas.

This series of articles is designed to give only a very general description of what has been done by engineers in the overseas portions of the Empire. The main purpose is to suggest, and even to prove, that British engineers can claim equal credit with statesmen, civil servants, and members of the defence forces, for the astonishing progress that has taken place in the Empire since British engineers inaugurated the power era by demonstrating the commercial value of many inventions connected with machinery.

We shall, first of all, consider what has been done in the Dominions—Canada, Australia, New Zealand, and South Africa. We shall then deal with India. For various reasons the economic and engineering developments in the Dominions have reached a more advanced state than has happened in the Crown Colonies and other Dependencies. Yet it must be remembered that the Empire, exclusive of the Dominions, covers twice the area of land occupied by that section called the Commonwealth of Nations.

In the past these British Colonies and Dependencies were more isolated from Britain and other parts of the earth than were the Dominions; that fact is painfully true of Burma, Malaya, and Hong Kong to-day. Many of these Colonies and Dependencies are within the tropics, and present splendid opportunities for greatly increasing the supply of food, raw materials, and power, which can be obtained if adequate engineering schemes are carried out. We have read of grants made by the British Government to aid the prosperity of these Colonies, but, despite the enthusiastic advocacy of a few far-sighted and influential people in Britain, one obtains the impression that not very much has been done to finance engineering schemes urgently needed to increase the prosperity of many Colonies.

A study of books, Government reports, speeches, and Press statements connected with Empire affairs has made me realise that, although there is a voluminous literature available to the student who seeks information about the Empire, there is but little mention of what has been a very big factor in the development of the Empire, viz., the important engineering progress made in many portions of it. The new civilisation, of which the British were the pioneers, is essentially technological, and that fact deserves more recognition by the British public.

It therefore seemed to me only right that there should be some record of what has been accomplished by British engineers in their efforts to build up this great civilising organisation called the British Empire, which has raised the standard of living for millions of natives and has relieved them of freedom from the fear of famine, floods, and devastating health conditions which formerly oppressed them. The humanitarian results of the work must be emphasised.

It is hoped that this attempt to describe what has been done overseas in the past may encourage some of the younger engineers in Great Britain to go out into other parts of the Empire in order to carry on the work of their forbears, work which has been of incalculable value to humanity.

Critics of the British Empire

The British Empire, which includes the British Commonwealth of Nations and much else besides, is a unique phenomenon in the history of the world. With the great empires of the past, it has little, if anything, in common. It is the remarkable result of British genius for colonisation, the practical application of scientific knowledge to a great variety of physical and social conditions, and of a successful adjustment to the continually changing economic and political conditions in a world in which human conceptions of distance, methods of communication, and the production of the necessities and the amenities of life, have been entirely changed during the last hundred years.

A tribute must be paid to the British naval architects and marine engineers who ensured British maritime supremacy during periods when, as now, our power at sea was challenged by jealous competitors for world trade. It is not proposed to describe their work, much of which is known to readers of this journal. But their influence upon the success of the Empire should never be forgotten.

It is necessary to explain briefly the background in the different places of the Empire overseas where applied science has transformed and improved the conditions of life of the residents. Engineers cannot work efficiently unless law and order is guaranteed and maintained. They have often found that their plans were delayed, and even frustrated, by political and commercial rivalries beyond their control. But they do not underrate the support which the establishment of justice, the devotion to duty of officials, and the heroism of members of the British Armed Forces have afforded them.

There has been in recent years evidence of the great interest, and also of the ignorance, which exists in the world concerning the organisation, the ideals of the designers, and the accomplishments of those who have brought into being the British Empire of to-day.

Propaganda and public speeches have done much to create false ideas about the Empire. Jealousy and the ambition of politicians, as well as ignorance, have caused much mischief in other countries. Even in Great Britain critics have shown either that they have been prejudiced by false information or they have not studied the history and the facts of the case.

In any huge organisation some mistakes are inevitable. Human nature cannot be controlled as easily as we now control the forces of Nature, although it must be confessed that at times even Nature hinders us with storms, earthquakes, &c., in our work; but, on the whole, we can control the forces of Nature more easily than human nature. Mistakes have been made during the building up of this huge organisation, the British Empire, but if the subject is fully investigated there is ample proof of its high overall efficiency.

Most serious for future concord in world affairs is what the Governor-General of Canada has called "the bitter criticism" expressed in the United States of America. In reply to it, he suggested as a leading illustration of the success of our work in the Empire a study of the history of Canada. In that country there is a society of mixed racial origins, to-day a free and autonomous people, within the larger British Commonwealth. It is a land made prosperous by modern engineering works.

The loyalty to the Empire to-day of many of those who, this century, fought against us in South Africa, is an example of the success of British efforts to conciliate and to deal justly with former opponents. In this case, again, much engineering progress has been made, since all the areas forming the Union came into the Empire.

We must leave the task of persuading these critics of the error of their ways to the statesmen of the Empire. General Smuts and eminent men in other parts of the Commonwealth have done so in the past and will no doubt continue to do so in the future. Engineers have given effective help by establishing rapid communications, so that a lie can be nailed quickly to the counter.

The Work Done by Engineers

It is notable that we find in the speeches, books, and pamphlets that criticise or defend the British Empire little, if any, reference to the remarkable civilising results achieved by reason of the engineering works which have developed its resources.

Engineers have done much to improve the conditions of life, to utilise the gifts of nature, and to provide trade in the Dominions and the Colonies, but those who toiled to do these things in out-of-the-way places of the earth are almost unknown, even to the general public of Great Britain. Their works remain, but very few people are aware of the obstacles surmounted, the dangers overcome, and the splendid results which the construction of these works made possible. The Governors and the politicians are, for a time at least, famous; their speeches and activities are reported. The engineers seldom emerge from the comparative obscurity of doing, rather than talking and seeking publicity.

Under trying conditions of climate and native labour, and often in fever-stricken areas, these engineers have made available modern transport facilities, communications of all types, and have provided mechanised power; they have improved waterways and ports; they have carried out reclamations and

irrigation schemes, built bridges, drained malarial swamps, diminished the perils of tropical diseases, and provided employment for large numbers of natives. They have developed the natural resources of the Empire for the benefit of humanity.

In the Early Days

All human history is a story of the sea. From the opening of the seapaths at the end of the fifteenth century down to the present day, the maritime instinct of a sea-girt people has sent some of the more adventurous ones into far distant places across the oceans.

The early merchant adventurers and mariners sailed from British ports out into unknown lands. They returned to tell strange tales of the wonderful things they had seen. They spoke of wealth to be had in exchange for cheap baubles; of strange people and of tropical products; they sought especially the spices, so valuable in those days for the preservation of meat, but now replaced by the more reliable refrigerating machinery, which preserves many other edibles which the spices only more or less preserved.

In coffee houses of the City the merchants talked of plans for foreign trade, and in the drinking dens near the river the sailors spun yarns which stirred the astonished listeners to long to sail into the far-away lands.

So the years went by, and, in a curiously haphazard fashion and at odd times, the Union Jack was unfurled on the shores of continents and on the hills and plains of out-of-the-way islands.

The Dawn of the New Technological Civilisation

Meantime, in England, Sir Isaac Newton and his followers were laying the foundations of a new civilisation, destined finally to affect the life of every human being on this earth. "The discoveries of science have belonged, and must belong again, to the whole world," said the President of the Royal Society recently, adding, "Newton's achievement is a part of the common heritage of all peoples."

The primary motive of the English who founded the early Colonies was to obtain cargoes of naval stores, timber, gold, silver, and other raw materials for the Homeland. There was another motive. It may seem to us incredible that the statesmen of the early seventeenth century were alarmed by the prospect of over-population, when England and Wales contained at most only 4,500,000 people, while this island nowadays sustains 45,000,000 inhabitants at a vastly increased average scale of living. Yet emigration was a national policy in those days.

Another powerful impulse to colonisation was supplied by religious and philanthropic enthusiasm. Puritans went to New England, Quakers to Pennsylvania, and Roman Catholics to Maryland, so as to secure freedom of worship.

The great event that was to usher in the transformation of Great Britain and many other parts of the earth occurred when, in 1785, James Watt produced a steam engine that earned money. There is an inscription inscribed on his monument, in Westminster Abbey, that preserves the memory of the selfless work of this great engineer. The record states that he "enlarged the resources of his country, increased the power of man, and rose to an eminent place among the most illustrious followers of science, and the real benefactors of the world."

While the Prime Minister of England was composing the inscription for the monument to commemorate the work of James Watt, more than 8000 miles away in a Far Eastern territory, another Englishman, named Raffles, was announcing the principle of trusteeship for native races within the British Empire. He also strongly advocated the abolition of the slave trade, which was accomplished in the British Empire in 1833. It can be said that history does not present a greater example of the humanitarian gesture of a nation than this action, which cost the British people £20,000,000 at a period when they were impoverished by the long financial strain of the Napoleonic Wars. Did they then realise that steam power was a better agent than slavery? While Governor of Java, during the British occupation of the island, and later in Singapore, Raffles stimulated the collection of scientific data relating to any tropical place he visited. He did his utmost to develop the natural resources of every area under his control.

Thus we see that the two fundamental factors in the success of the British Empire of to-day were enunciated and practised by the founder of Singapore, who is commemorated by a statue in the London Zoo, which he founded.

The Three British Empires

The evolution of the Empire has resembled that of any of the main branches of engineering science. Just as power production commenced with the inventions connected with the steam engine and now includes power supplied by steam turbines, gas and oil engines, and hydro-electric machines, so did the British Empire commence as a trading concern which began to involve the King and Government of Great Britain to such an extent that they had to assume responsibility, often very reluctantly, in distant lands, in order to protect the lives and property of their subjects. As experience was gained, the British people and those overseas expanded their outlook and gained new ideas, and as communications improved and increased facilities for contact, adjustments in methods of government were made, and new enterprises and more important engineering developments were initiated in many parts of the Empire.

There have been three distinct British Empires. The first lasted from the early sixteenth century until it was shattered into fragments by the stupidity of King George III and his advisers.

Nothing daunted by that catastrophe, the British built up out of the ruin a second Empire, formed partially from the spoils of the Napoleonic Wars and partially by peaceful colonisation and negotiation. It expanded for a century, mainly because of the development of mechanised industry, for European nations began a scramble for territories containing the raw materials needed for increased production, and the British felt that they had to have their rights respected.

Then, after the end of the war, in 1918, there came into being the third British Empire. The Dominions became equal partners with the Homeland. General Smuts and others suggested that as the word "Empire" connoted "rule," the Dominions and Great Britain should be called the British Commonwealth of Nations.

The Prosperity in Britain

It is assumed that readers are aware of the chief engineering works that have been carried out in Great Britain. If not, they can easily refer to the numerous technical publications which have described them, and so it is superfluous to dwell upon them.

There is not the same easy facility for learning about the achievements of engineers in other parts of the Empire. Some readers may have detailed knowledge concerning technology in this or that Dominion or Colony. They may feel that greater reference to the engineering works they know should be given. Space is limited; many volumes could be written if all technical details were included. Any suggestions or facts that will enable the writer to make this record more complete will be gratefully acknowledged.

As a nation we have in the past relied for our prosperity very much on the initiative and enterprise of industrialists, and have not had very much confidence that those in the employ of the Government show those qualities; there has often been considerable opposition to suggestions of Government control of engineering schemes.

On the other hand, there is now a general recognition of the fact that financial assistance by the British Government must be granted to Crown Colonies for their economic development, and that must mean an expansion of engineering works in those areas. My own observation has made me convinced that engineers employed on such public works as roads, railways, reclamations, irrigation schemes, &c., have served faithfully and efficiently. They have invariably supervised, carefully, the conditions that are essential if native labour is to work efficiently.

The future prosperity of the British Empire is dependent on the extension of engineering works in all parts of it; fortunately, that fact is now fully realised by Empire statesmen. While it is essential that Governments should finance and carry out much of the work, there are and will be many opportunities for private enterprise. Some large engineering firms in Britain have established branch factories in the Empire overseas and we may expect a considerable extension of that system. Some firms have also established offices, where engineers trained in their own establishments, handle technical details and search for opportunities to promote exports. That system also will, no doubt, be greatly extended in the post-war years.

There are great possibilities for the future of the British Empire and to that great future the achievements of British engineers will contribute a very important factor. As we survey what has been accomplished in past years and realise the vast natural resources yet awaiting development, we can be satisfied that, once again, the British Empire will take a leading part in ensuring for large numbers of human beings all over the earth relief from poverty and disease, and greatly improved conditions of living, as well as justice and safety.

(To be continued)

Branch Line Abandonments in U.S.A.—Abandonment of branch lines in America reached a new high level of mileage in 1942. This has taken place despite increasingly strenuous opposition by local authorities on the ground that the difficulties of road transport owing to shortage of tyres and petrol might leave places served by many of these railways without transport if the railways were to be dismantled. In a few cases this opposition has been successful in obtaining from the Interstate Commerce Commission a refusal to permit abandonment or at least a deferment. On the other hand, there has been the double urge, first of the War Production Board to obtain the released rails and permanent way material for urgent defence projects, and, secondly, of the railways themselves to release locomotives, coaches, wagons, and staff from unproductive duties, when all the rolling stock and men available are urgently needed elsewhere. For the first time in American history lines taken up have exceeded in length 2000 route miles, reaching the record figure of 2516 miles. The nearest approach to this abandoned mileage was the 1995 miles in 1934.

America's Wartime Merchant Fleet

(By an American Correspondent)

No. V—*(Continued from page 324, April 23rd)*

BETHLEHEM-FAIRFIELD SHIPYARD

BETHLEHEM - FAIRFIELD SHIPyard, Inc., at Baltimore, Md., is the largest of the emergency shipbuilding plants on the Atlantic seaboard of the country. From the beginning of its establishment it has led in its special field of service on the Eastern Coast, and at the close of 1942 it claimed a record of seventy-seven "Liberty" ships and eleven other vessels of a special type, the eighty-eight craft totalling more than 800,000 deadweight tons.

The U.S. Maritime Commission has stated that the yard would have delivered in excess of 100 ships last year had not a considerable portion of its facilities been diverted to a special type of construction for the armed Services. Even so, the performance was an extraordinary one, and especially so in view of the fact that the shipyard virtually did not exist until some time in April of 1941, and then only in its initial stage of development.

Bethlehem-Fairfield Shipyard is an affiliate of the great Bethlehem Steel Company, which has for years operated extensive shipbuilding plants on both the Atlantic and Pacific coasts with the largest staffs of experts and men trained for such service in the country; and happily such was the case when President Roosevelt called upon the U.S. Maritime Commission in January of 1941 to build with all practicable despatch 200 cargo steamers of "EC-2" type, since generally known as "Liberty" ships, and each of about 10,500 deadweight tons. At that time the shipyards of the country were crowded to capacity with naval and Maritime Commission's vessels, which had required the shipyards to amplify their facilities and to increase the number of their slipways. Those yards had absorbed all men available that were familiar with ship construction work.

The Maritime Commission, only momentarily staggered by the new task laid upon its already burdened shoulders, sought the counsel and co-operation of the country's shipbuilders and others qualified to help in dealing with the new problem. The solution decided upon was to create seven entirely new shipyards to build the 200 sorely needed freighters. The new shipyards were to be affiliated with a corresponding number of the older and most experienced shipyards, which were also to supply the necessary administrative and supervisory organisations, by assigning a limited number of their leading men for the new plants. These experienced men, fewer than would ordinarily be considered ample for the purpose, were given the twofold job, at each new yard, not only of directing the building of the allotted number of ships, but also that of training the workers who were expected to build those ships. The seven new yards were to be situated on privately owned properties and to be operated as private enterprises at locations sufficiently removed from other shipyards not to hamper their established operations. The new shipyards were further to be spread upon the Atlantic seaboard, the Gulf Coast, and the Pacific Coast to distribute the work, and each yard was to be placed in contact with or accessible to trunk line railways, and also in sections of the country adjacent to centres of labour.

On February 4th, 1941, the U.S. Maritime Commission awarded Bethlehem-Fairfield Shipyard, Inc., a contract to create a thirteen-slipway plant at Baltimore. Bethlehem-Fairfield Shipyard, Inc., on March 15th following, closed leases for four properties, totalling 174 acres, on or adjacent to the estuary of the Patapsco River, in the Fairfield section of Baltimore. The landlocked waters of great Chesapeake Bay are but a few miles distant and admirably suited for running acceptance trials and for giving access to the sea. One of the four properties was owned by the Union Shipbuilding Company, had four slipways that had been idle since World War I and required complete rebuilding to be of service, and two 400ft. piers, of which one was useless and had to be dismantled and built anew, 900ft. long, while the other pier had to be underpinned with new piles, completely redecked, and doubled in length. A marine railway, previously used only for ship scrapping work, was of no value to the new yard and was cleared away; but there were an office building, a warehouse, a machine shop, and a paint shop, all of which could be utilised at the start by Bethlehem-Fairfield Shipyard. The fourth property, two miles away on the shore of Curtis Bay, is owned by the Pullman Standard Car Manufacturing Company, but had been unused for five years. The buildings on that 38-acre site were readily susceptible of adaptation for a fabricating plant for the new shipyard. Some machinery in the car manufacturing plant could be put in service again, when rearranged, while other of the idle machinery had to be scrapped and new machinery, especially suited for the work ahead, was obtained and put in place where needed. The two-mile separation between the fabricating plant and the shipyard was unavoidable. The company had to link the shipyard and the fabricating plant by means of the Baltimore and Ohio Railroad in order to move fabricated parts to the shipyard. The lay-out has imposed some handicaps, because transit between the two plants entails a loss of time, and railway traffic has to subscribe to Government requirements as to clearances, which limit the sizes of sub-assemblies that can be moved from the fabricating plant to the shipyard and handled efficiently while keeping up the flow of materials between the two main subdivisions of the enterprise. Although Bethlehem-Fairfield Shipyard has had to violate the biblical injunction against putting new wine in old bottles by making use of previously employed facilities, still it will be evident presently how thoroughly that company has mastered the physical difficulties and achieved a record performance.

Fairfield Shipyard—by which name we shall call it henceforth—was advanced so rapidly during its creation that it was possible to lay the keel for the first "Liberty" ship in the spring of 1941. Construction work on the yard was taken in hand shortly after March 18th of that year by Booth and Flynn, of Pittsburgh, Pa., and one of the old slipways was renovated and made available on April 30th for the laying of the keel of the craft which was launched, as the "Patrick Henry," 150 days later. Ninety-four days after being put in the water that vessel, following successful speed trials in Chesapeake Bay, was delivered to the Maritime Commission on December 30th, 1941. Before the last of the originally ordered thirteen slipways was completed, Fairfield Shipyard received a contract for three more slipways, and all sixteen ways were in use by the close of 1942.

When Fairfield Shipyard signed its initial contract for fifty ships on March 14th, 1941, the yard was required to deliver every one of those vessels by March 18th, 1943, and it was expected to do within the time allotted what had never been done before. Fairfield Shipyard, like the six other yards engaged in turning out the original group of 200 "Liberty" ships, did not get into its production stride until well into the first half of 1942. Still that plant completed and delivered its fiftieth ship on August 18th of that year—exactly seven months earlier than specified in the contract. The yard would have made an even more astonishing record in 1942 had it not been called upon to devote a considerable part of its facilities to turning

LIBERTY SHIP UNDER CONSTRUCTION

out a number of vessels of a special type for the armed Services. During January of this year the Fairfield Shipyard maintained its leadership among the emergency shipyards on the Atlantic seaboard by completing and delivering five "Liberty" ships and eight vessels of special type, and by March 18th of this year—the conclusion of the original two-year period for building fifty ships—the yard delivered its 131st vessel. The shipyard's own schedule now calls for the delivery of more than 200 vessels during the present year.

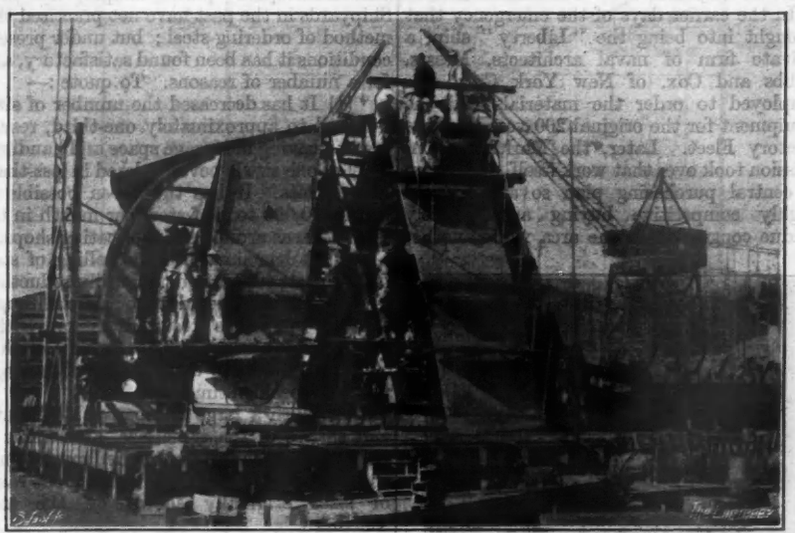
The "Patrick Henry," delivered at the end of 1941, required 244 days between keel laying and delivery. The "William Tilghman," the fiftieth ship completed at Fairfield Shipyard, was launched forty-eight days after keel laying, and was delivered eleven days later, the total time of construction being fifty-nine days, or about a quarter of the time taken for the "Patrick Henry." The yard started to deliver ships to the Maritime Commission at the rate of twelve a month in July of last year. Such is the summary of what the Bethlehem organisation, with its ripe experience, has proved possible with prefabrication, a very wide use of welding, and the adoption of mass production methods in shipbuilding.

Production Methods

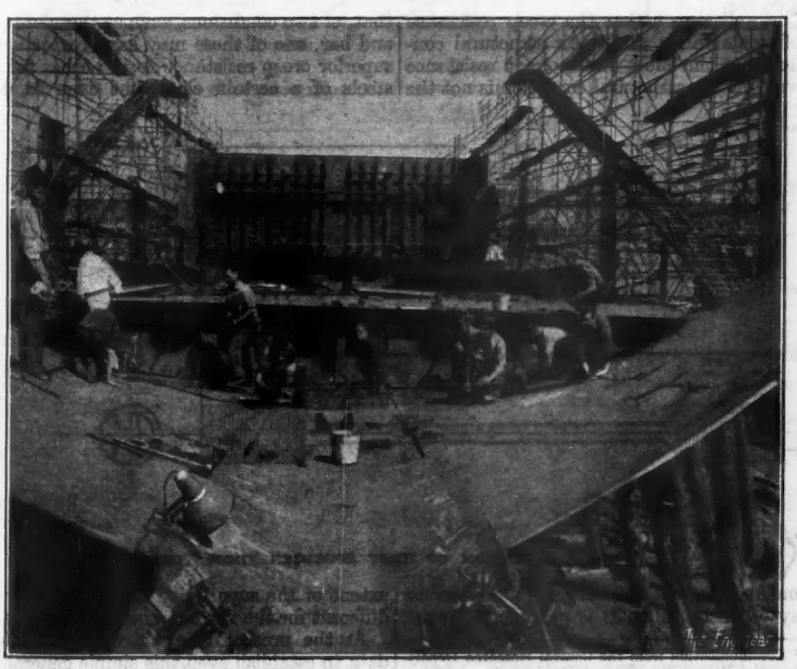
Having completed the fiftieth ship in August of 1942, and having continued to build "Liberty" ships and another type of craft since at an accelerated rate of output, it should be manifest that Fairfield Shipyard has received additional contracts from the Maritime Commission from time to time. The extent of the increased activity at the yard and the associate fabricating plant can be measured with fair accuracy by the growth of the working force. At the beginning of April, two years ago, 355 people were employed; on January 1st, 1942, the pay roll registered a force of more than 11,000, and three months later the pay roll force slightly exceeded 20,000. By the end of last year the total working force at the shipyard and the fabricating plant was greater than 35,000. To use advantageously so large an organisation the company has devised a production system that calls for the fullest practicable use of power, machinery, and other available facilities during three shifts in each twenty-four-hour day, and seven days of every week. The number of ships scheduled to be built each month determines the working programme for that period and also how the workers shall be assigned their activities at the fabricating plant and at the shipyard so as to assure a co-ordinated or balanced total effort.

The supervisory task in this matter primarily rests with the production department, which takes the plans received from the Maritime Commission and, after analysing all drawings for a "Liberty" ship, determines how the structural parts shall be fabricated, and arranges for their sub-assembly, flow to the shipyard from the fabricating plant, and the sequence of their erection on the several building ways. The procedure is intended to make the best and most effective use of every productive agency and to employ each and all of them at maximum capacity while maintaining a steady and ordered tide of prefabricated ship parts to the storage areas in the shipyard, immediately adjacent to the different slipways. Both crowding and lagging are carefully avoided.

The workers engaged in doing the fabricating and sub-assembly jobs are not supplied with the conventional blue prints heretofore used in the older shipyards. Instead, they are furnished with simple isometric drawings, which give angular views that make a sub-assembly readily understandable to the normal picture-hungry mind of non-technical men. There may be 600 of these separate drawings for the different fabricating and sub-assembly ship parts, but usually a single drawing is all the guide needed for a worker or a small group of workers, although in some instances two or three of these isometric projections may be needed for the more complicated sections. These graphic aids have been of great help in creating in a short while competent working forces from "green hands," for the fabricating plant and for the shipyard. Any changes that may be made in the ship design or any alterations ordered by the Maritime Commission are promptly noted and recorded by the planning office of the Fairfield Shipyard, and all blue prints and other graphic guides are immediately issued from that source to the particular divisions of the organisation which may be concerned. While isometric drawings enable a worker or his group quickly to grasp what has to be done, the assignment to given tasks that are to be repetitive leads to increasing speed of performance as they are done again and again, day after day.



PREFABRICATING A BOW ASSEMBLY



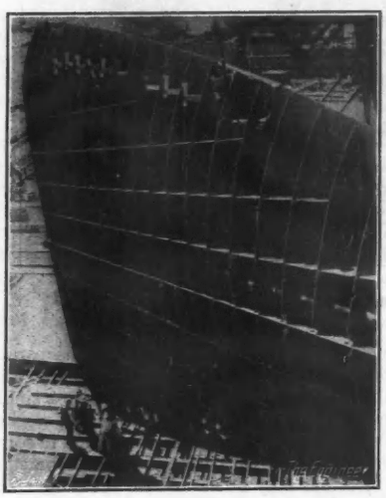
WORK ON BOTTOM PLATING

The multiple-production jobs of the various operating departments of Fairfield Shipyard are so synchronised with the daily and weekly schedules arranged by the management in connection with keel layings, launchings, structural completion, trial trips, and deliveries that all activities move along smoothly and bottlenecks are avoided. The fabricating plant and the slipways are so nicely intermeshed that they function virtually as a single production machine.

To visualise the true nature of what Fairfield Shipyard is doing, and doing well, one must realise that this new order of shipbuilding is, in effect, an adaptation of the assembly line of the familiar automobile plant and other manufacturing establishments engaged in quantity production on a large scale. The older order of shipyard,

which commonly manufactured the propelling engines, boilers, pumps, and much of the other equipment placed in a completed vessel, could not deal adequately in its comparatively leisurely way with the demands now made upon the yards engaged in turning out "Liberty" ships in great numbers and in a short while. The Fairfield Shipyard has two dominant functions to perform: to construct hulls and to install in them all required equipment that is mainly obtained from other sources, more or less remote, but immediately or intermediately through the Maritime Commission.

In the earlier days of the emergency that brought into being the "Liberty" ship, a private firm of naval architects, Messrs. Gibbs and Cox, of New York City, was employed to order the materials and the equipment for the original 200 vessels of the Victory Fleet. Later, the Maritime Commission took over that work itself, and set up a central purchasing plan so as to avoid highly competitive buying and possibly undue congestion in one area while another



PREFABRICATED SECTION OF FLOORS AND INNER BOTTOM.

area might be short of work. The efficient procurement of steel, engines, gears, and auxiliary equipment plays an important part in making possible shipbuilding production records, inasmuch as it is necessary at all times to have an orderly flow of materials delivered at the right time at the right place.

THE ORDER DEPARTMENT

The ordering department of Fairfield Shipyard proceeds as follows in this matter of essential supply:—The data necessary for ordering are obtained from the plans and specifications, and next all similar materials are covered in bulk orders to avoid duplication and to simplify the control and disbursement of the materials when they reach the shipyard. The ordering department then asks the purchasing department to obtain competitive bids on the desired materials, and when the bids have been received and tabulated, the vendor or vendors, as the case may be, are recommended, and the tabulations go to the Maritime Commission's purchase controller for approval. When that approval has been obtained from the Maritime Commission, a requisition is written that authorises the purchasing department to place the order with the selected vendor. The ordering department also submits details covering steel plates, shapes, and bars that may be needed for ship construction. The Maritime Commission, in the matter of materials, works in collaboration with the War Production Board, and so saves much time that might be lost if the private enterprise had to deal with that dominant organisation.

The foregoing arrangement has other advantages which are emphasised whenever changes are made in plans and specifications. For instance, it became necessary to make some changes in the original plans, and these entailed "taking off" the necessary steel from the altered plans. All the steel data were then so assembled as to show that it would be feasible to reduce in number and sizes the required plates, shapes, and bars. Shipyards in the past have not practised this method of ordering steel; but under present conditions it has been found satisfactory, and for a number of reasons. To quote:—

"(1) It has decreased the number of sizes required to approximately one-third, resulting in a saving in storage space and handling. Steel of one size is never ordered in less-than-carload lots. It has thus been possible to handle 70,000 tons of steel per month in the limited areas around the fabricating shops.

"(2) It has simplified the rolling of steel from the standpoint of steel mill production.

"(3) Interchangeability of sizes throughout the ship has resulted in preventing delays, which might be chargeable to failure of the steel mill to deliver part of an order within a specified time.

"(4) With a large number of steel plates and shapes of the same size, alterations to the ship structure can be applied much sooner than if steel were ordered in the great range of sizes originally shown on the steel schedules."

The ordering department, collaborating with the planning and production departments, sends the steel schedules to the steel mills, incidentally giving the dates for required delivery. The steel schedules are issued each month and specify the sizes of the steel material needed, in accordance with the production schedules, for the construction of ships.

It will be understandable from what has preceded that the shipyard has a sizable task in keeping count of all incoming materials and in checking their correctness as to types, quantities, &c., against the orders issued for them by the purchasing department. While the work involved may seem somewhat complex, still it is carried out in a systematic and orderly manner that has proved thoroughly satisfactory. The system is thus outlined:—"A card file, showing each individual type of material, is created and, no matter in how many different places each distant type of material is used, all are shown on the same material card. Although approximately 95 per cent. of all material used at Bethlehem-Fairfield Shipyard is ordered directly by the Maritime Commission originally, in most instances anywhere from five to twenty different purchase orders were issued, all applying to the same type of material. That was the consequence of each order being made up directly from the primary bill of material shown on each separate drawing, and, as might be expected, many duplications resulted.

"By pooling materials, as mentioned, the number of purchase orders and the number of vendors could be lessened and, in turn, that has lightened the burden involved in expediting, storing, and disbursing such materials. Reports are made to the central material office by each department of any damaged or defective materials, and replacements are made to balance receipts. Furthermore, periodic physical inventories are made to balance stock to disclose losses, errors in estimates, orders, &c., and so make it possible to keep a fixed, predetermined amount of stock on hand at all times."

(To be continued)

Creep Resistance of Superheater Tube Steels in Tube and Bar Form*

By J. A. JONES, M.Sc., and W. E. BARDGETT, B.Sc., A.M.I. Mech. E.

IT is well known that the creep resistance of steels varies with their structural condition, but the effect on the creep resistance of varying the structural condition is not the same for all steels, so that general statements may be misleading. It is possible, however, that, of two conditions, such as those of tube and bar, one of these may have respectively superior creep resistance to the other for all steels of a certain class, but even so, the extent of the superiority would probably be different for the various steels of this class.

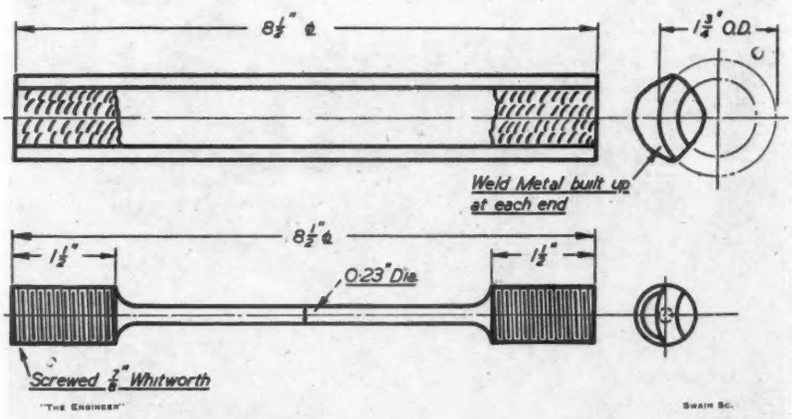


FIG. 1—PREPARATION OF TEST SPECIMEN FROM TUBE.

At the present time there is insufficient data to establish even this simple generalisation in the particular instance of tube and

* Communication from the Central Research Department, The United Steel Companies, Ltd., Stocksbridge, Sheffield.

bar material. The extent to which creep test data obtained on bar material are representative of tube material is a matter of considerable importance to the engineer and metallurgist and must be determined for the particular steel qualities concerned if speculation is to be avoided.

The following records the results of creep tests carried out on two established qualities of superheater tube steel, one of chromium-molybdenum type (Esshete CML) and the other of ½ per cent. molybdenum type (Esshete D4C) in tube and bar form. Particulars of these steels are given on page 8.

For the purpose of these tests lengths of tube were supplied by Messrs. Babcock and Wilcox.

CHROMIUM-MOLYBDENUM QUALITY (ESSHETE CML)

Creep Tests.—The method of preparation of the test specimens is illustrated in Fig. 1. Lengths of tube were cut longitudinally into four pieces, each of which was built up at the ends with weld metal. The ends were then screwed to suit the adaptors of the creep machine and a central portion constituting the test length, of slightly smaller diameter than the thickness of the tube, was prepared. Care was taken to ensure that the heat affected tube material was outside the parallel length.

Creep tests were carried out at various stresses ranging from about 5 to 11 tons per square inch at 1000 deg. Fah. (538 deg. Cent.). The tests were continued beyond forty days in order to determine the creep rate at this period. The results of all the tests, together with those obtained on the bar material, are given in Table I below and in the form of strain-duration curves in Figs. 2 and 3.

TABLE I.—*Temperature of Test*, 1000 *Deg. Fah.* (538 *Deg. Cent.*).

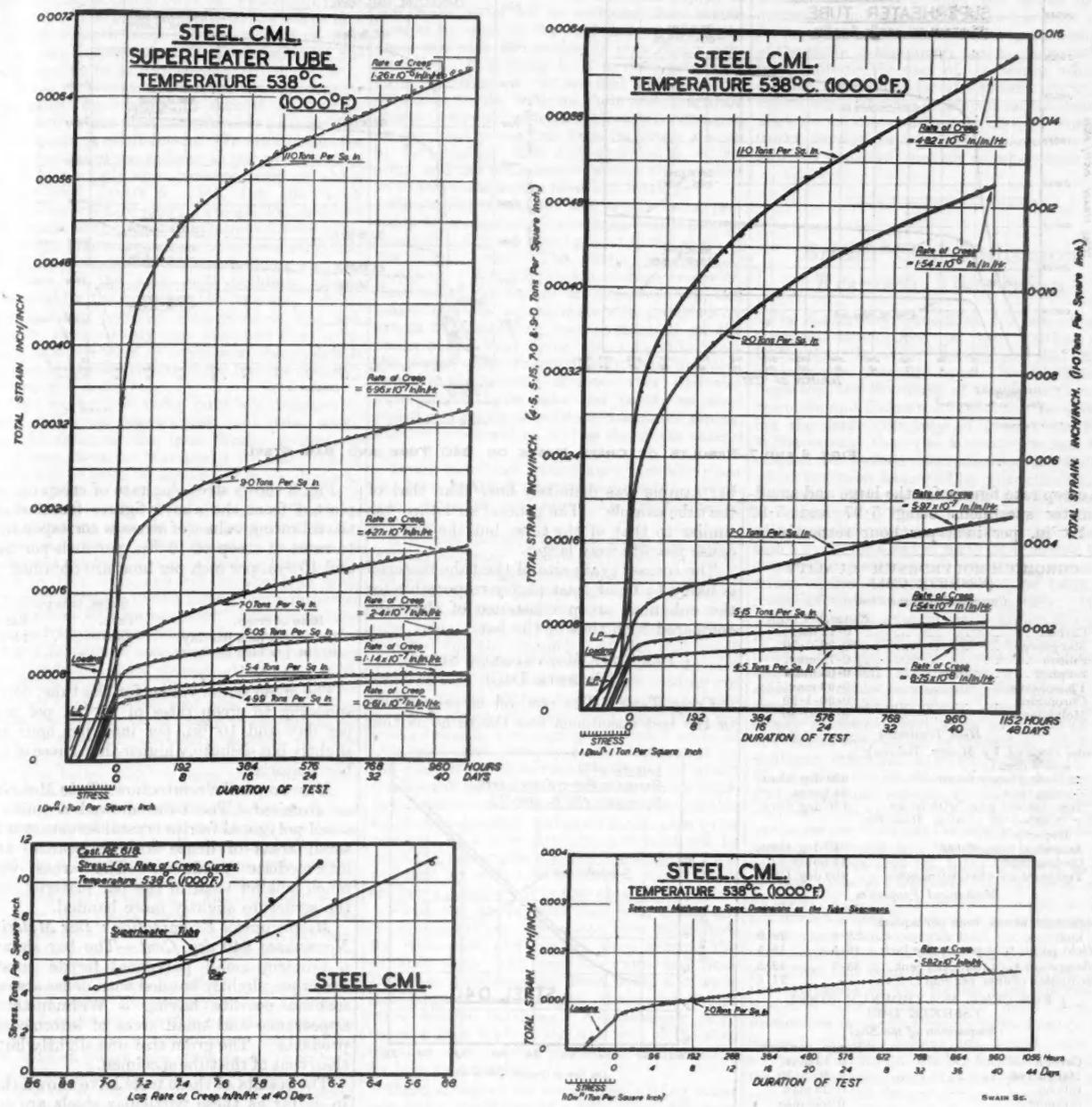
	Stress, tons per sq. in.	Rate of creep at forty days, inch per inch per hour $\times 10^{-7}$.
Tube	4·99	0·61
	5·40	1·14
	6·05	2·40
	7·00	4·27
	9·00	6·96
	11·00	12·60
Bar	4·50	0·675
	5·15	1·54
	7·00	5·97
	9·00	15·40
	11·00	48·20

Fig. 4 shows stress-log rate of creep curves, plotted from the above figures, from which the following values of stresses corresponding to rates of creep of 10^{-6}in. and 10^{-7}in. per inch per hour are obtained :—

	10^{-6}in. per inch per hour, tons per sq. in.	10^{-7}in. per inch per hour, tons per sq. in.
Tube	10·1	5·1
Bar	8·0	4·6

The creep stress values of the tube, corresponding to creep rates of 10^{-6}in. and 10^{-7}in. per inch per hour, are respectively about 25 and 10 per cent. greater than those of the bar material.

In view of the possibility of the different sizes of specimens, adopted in the tests on tube and bar having an influence on the creep test figures, a specimen was prepared from the bar having the same dimensions as the



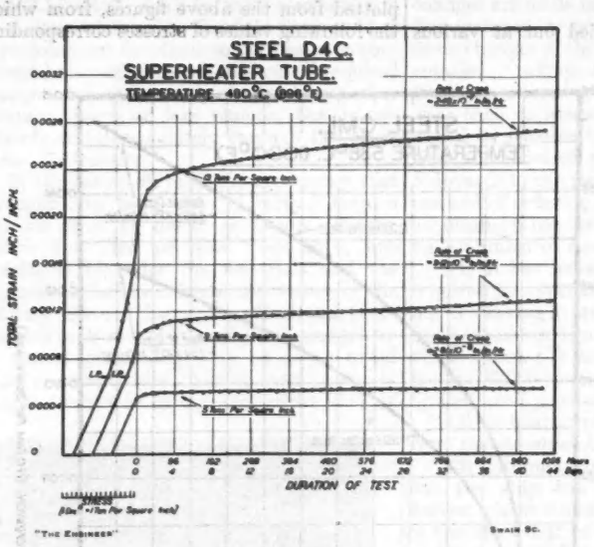
FIGS. 2 TO 5—RESULTS OF CREEP TESTS ON CML TUBE AND BAR STEEL

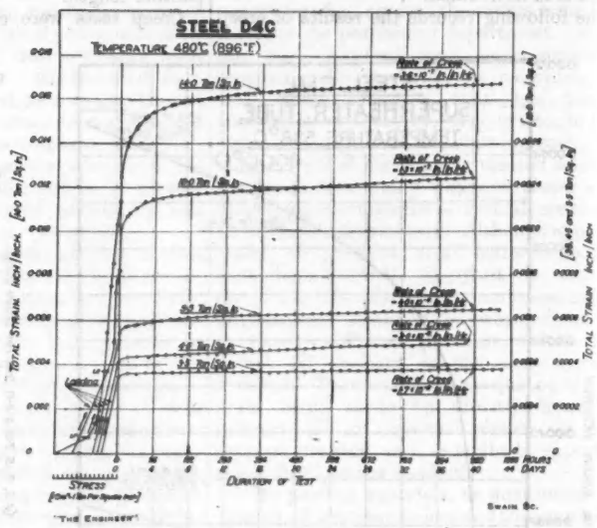
tube specimen. This was tested at 7 tons per square inch at 1000 deg. Fah. (538 deg. Cent.). Comparison of the strain-duration curve for this test, Fig. 5, with the corresponding curve on the bar (0·564in. diameter) shows that there is no size effect in the tests, which is less than the possible normal variation for specimens of the same size.

Microscopical Examination: Tube Material, as Received.—The structure showed a banded appearance and consisted of small ferrite grains and areas of dense sorbitic pearlite with carbide particles precipitated at the grain boundaries and within the grains.

Microscopical Examination: Bar Material, Annealed 940 deg. Cent.—The grain size of the bar sample was definitely finer than that of the tube sample. The general structure was similar to that of the tube, but the areas of dense pearlite were larger.

The coarser grain size of the tube material is likely to be at least partly responsible for the enhanced creep resistance of the tube compared with that of the bar.





FIGS. 6 AND 7—RESULTS OF CREEP TESTS ON D4C TUBE AND BAR STEEL

the creep rate figures for the large and small-diameter specimens being 5·97 and 5·92 by 10^{-7}in. per inch per hour respectively,

CHROMIUM-MOLYBDENUM QUALITY
(ESSHETE CML)

Composition of the Steel

	Range, per cent.
Carbon	0·12 max.
Manganese	0·30–0·70
Silicon	0·75 max.
Sulphur	0·03 max.
Phosphorus	0·03 max.
Chromium	0·60–1·20
Molybdenum	0·40–0·80

Heat Treatment

Tube (treated by Messrs. Babcock and Wilcox):	
Annealing temperature	930 deg. Cent.
Cooling time	24 hours
Temperature when withdrawn	180 deg. Cent.
Bar (treated in Central Research Department):	
Annealing temperature	940 deg. Cent.
Cooling time	14 hours
Temperature when withdrawn	400 deg. Cent.

Mechanical Properties

	Tube.	Bar.
Maximum stress, tons per square inch	25·6	28·0
Yield point, tons per square inch	16·5	18·5
Elongation $4\sqrt{A}$ (bar), per cent.	55·0	42·5
Reduction of area, per cent.	—	71·6

½ PER CENT. MOLYBDENUM STEEL
(ESSHETE D4C)

Composition of the Steel

	Range, per cent.
Carbon	0·12 max.
Manganese	0·30–0·70
Silicon	0·35 max.
Sulphur	0·030 max.
Phosphorus	0·030 max.
Molybdenum	0·45–0·60

Heat Treatment

Tube (treated by Messrs. Babcock and Wilcox):	
Normalising temperature	950 deg. Cent.
Time at temperature	½ hour
(Tubes cooled in atmosphere, 6in. apart.)	
Bar, 1in. diameter (treated in Central Research Department):	
Normalising temperature	930 deg. Cent.
Time at temperature	½ hour

Mechanical Properties

	Tube.*	Bar.
Maximum stress, tons per square inch	29·6	29·0
Yield point, tons per square inch	17·0	15·8
Elongation $4\sqrt{A}$, per cent.	46·8	41·5
Reduction of area, per cent.	79·0	75·6

* Test piece similar to long time creep specimen.

½ PER CENT. MOLYBDENUM STEEL (ESSHETE D4C)

Creep Tests.—The method of preparation of the test specimens was the same as that adopted in the case of Esshete CML tube samples, the only difference being that in the present instance the tube sample was 2in. outside diameter, compared with 1¾in. outside diameter for the Esshete CML tube.

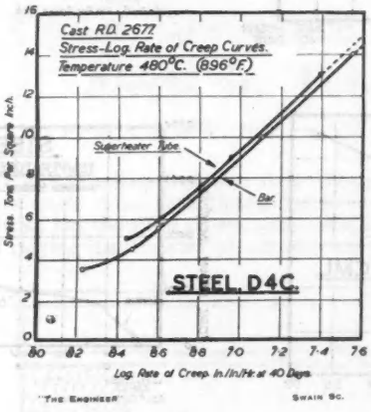


FIG. 8

TABLE II.—*Temperature of Test, 480 Deg. Cent. (896 Deg. Fah.)*

Material.	Stress, tons per sq. in.	Rate of creep at forty days, in. per inch per hour.
Tube	5·0	$2·81\times10^{-8}$
	9·0	$9·12\times10^{-8}$
	13·0	$2·48\times10^{-7}$
Bar	3·5	$1·7\times10^{-8}$
	4·5	$3·0\times10^{-8}$
	5·5	$4·0\times10^{-8}$
	10·0	$1·3\times10^{-7}$
	14·0	$3·6\times10^{-7}$

Creep tests were carried out at stresses of 5, 9, and 13 tons per square inch over a period of approximately forty-four days at a temperature of 480 deg. Cent. (896 deg. Fah.) in order to determine the creep rate at forty days. The results of all the tests, and of those obtained on the bar material, are given in Table II and in the form of strain-duration curves in Figs. 6 and 7.

Fig. 8 shows stress-log rate of creep curves plotted from the above figures from which the following values of stresses corresponding to rates of creep of 10^{-8}in. per inch per day and 10^{-7}in. per inch per hour are obtained.

Rate of creep.	Stress, tons per sq. in. Tube.	Bar.
10^{-8}in. per inch per day	15·0	14·6
10^{-7}in. per inch per hour	9·4	9·0

The creep stress values for the tube, corresponding to creep rates of 10^{-8}in. per inch per day and 10^{-7}in. per inch per hour are slightly but definitely higher than those of the bar material.

Microscopical Examination: Tube Material, as Received.—The tube showed a uniform small polygonal ferrite crystal structure with small areas of dense sorbitic pearlite and intermediate products. The areas were much smaller than in the bar material, and the structure slightly more banded.

Microscopical Examination: Bar Material, Normalised 940 deg. Cent.—The bar showed a uniform small polygonal ferrite crystal structure, slightly banded with dense areas of sorbitic pearlite having a Widmanstätten appearance and small areas of intermediate products. The grain size was slightly larger than that of the tube specimen.

The results of these tests have shown that, in so far as these particular steels are concerned, and provided that the tubes are produced by a satisfactory method of manufacture and heat treated under properly controlled conditions, the application of results of creep tests on bar material to tube design introduces a factor of safety of 25 per cent. in the case of the chromium-molybdenum steel for a rate of creep of 10^{-7}in. per inch per hour. The creep stress figure for the ½ per cent. molybdenum steel in the form of bar may be taken as directly applicable to the corresponding tube material.

The authors are particularly indebted to Mr. C. Humphrey Davy for kindly arranging the supply of the samples, together with full particulars of the tubes manufactured by Messrs. Babcock and Wilcox, whilst they wish to thank Dr. T. Swinden, Director of Research, the United Steel Companies, Ltd., for permission to publish the results.

The Vanderbijl Steel Works, Transvaal

(By our Correspondent in South Africa)

ABOUT a year ago reference was made in THE ENGINEER to the preliminary work which had been put in hand for the new plate mill which is being built at Vanderbijl, near Pretoria. The progress made on the works now enables a much more detailed picture of what has been accomplished in the erection of the undertaking to be furnished.

Work on the excavation for the mill and its buildings, &c., began in earnest in August, 1942, and since then considerable progress has been made in all directions. In addition to the construction of the railway to the works and of the water supply arrangements, work on which commenced earlier in 1942, the site work now completed, or nearing completion, includes the whole of the main foundations for the plate mill and practically all its accessories, together with the foundations for the building and the erection of the main mill building. Some material for the mills and the necessary reheating furnace, together with some of the mill cranes, have already been delivered from overseas, and the work of erection of these parts is in hand. Construction of the furnace chimney is also well under way.

The works now being built are designed to operate for the present with cold slabs, which will be rolled at the Iscor Works at Pretoria and sent down to Vanderbijl by rail. These slabs will be received and stored in a slab stockyard, which is 400ft. long by 100ft. wide, the slabs being handled from the railway and into the reheating furnace by means of a 25-ton overhead crane. The reheating furnace is producer gas fired, having a heating hearth 80ft. long by 18ft. wide, and will be capable of heating cold slabs up to the rolling temperature at the rate of 50 tons per hour. Space has been allowed for the construction in the future of a second furnace of similar size. The necessary gas producers, coal storage plant, and cold-handling equipment for delivering coal from railway trucks to the coal bins and the boiler plant for the supply of steam to the producers and to the mill are being erected in close proximity to the furnace. The brick chimney for this boiler plant is now practically completed.

The plate mill itself is of the latest American design and will be erected in the mill bay of the buildings, which is 500ft. long by 90ft. span, and has a height up to the crane rails of 36ft. For the construction and servicing of the mill there is being provided a 75-ton overhead crane.

After the plates have been rolled to size they will travel to the east end of the mill bay, at which point they will be transferred to a cooling bed and will then pass into the plate-finishing bay, which is 625ft. long by 100ft. span, in which the crane rails are also 36ft. above the ground. In this bay there will be a 25-ton crane and a 10-ton crane for handling the finished plates into stock or on to railway trucks for dispatch. The cooled plates will be marked off to size in this bay, then transferred by a short transfer table to another set of rollers leading to the shearing department, in which the plates will be cut to exact sizes, after which they will be weighed and placed in stock or dispatched as required.

Parallel to the mill bay and on the opposite side from the finishing bay is situated the motor house, a brick building, 400ft. long by 50ft. wide, in which will be housed the main mill driving motor, which at peak load will develop 17,000 H.P., together with the necessary flywheel motor generator set for this motor with its accessories, and also the rotary converters for the supply of direct current to the mill auxiliary motors. In addition, all necessary switchboards for the control of high-tension alternating and direct current will be situated in this motor house. Outside the motor house there will be a platform carrying the transformers belonging to the main mill motor equipment, the rotary converters and the low-tension A.C. supply.

The cooling of the main mill motor will be done by means of air under slight pressure blown into the machine, and then discharged to atmosphere outside the motor house, this air being filtered and washed before it passes to the motor. Other electrical machinery in this house will be cooled by washed and filtered air pumped into the building from outside and discharged again through underground ducts to atmosphere, the building itself thus being under slight pressure. The electrical supply to the motor house will be delivered from a sub-station situated at the east end of the works area, and this sub-station is now under construction. It is being built in close proximity to a transformer station and switch house belonging to the Victoria Falls and Transvaal Power Company, which has already constructed an overhead power line from its power station at Vereeniging. This line operates at 80,000 volts, and the transformers reduce the pressure to 11,000 volts at the Iscor sub-station.

Circulating water for the mill is being provided by a number of circulating water pumps, situated in a pump house placed to the south of the motor house. The pumps deliver their water to a 5-million-gallon storage reservoir, constructed on top of an adjacent hill, and make-up water to the system is provided by means of a pumping station situated on the banks of the Vaal River, about 8½ miles from the works. The interconnecting pipe line consists for the present of three 12in. diameter pipes which have been laid partly as steel piping and partly as reinforced concrete piping. Further pipes will be laid as the works extend in the future.

In the meantime a temporary pumping plant has been installed, and is providing the necessary water at the works for constructional purposes.

The new branch railway from the South African Railways' Johannesburg and Vereeniging line was brought into commission in October last, and the temporary railway tracks which were laid to the works area at that period are now being replaced by the permanent tracks required for the operation of the mill itself. As the new works are situated in an area somewhat remote from the main roads leading out of Vereeniging, it has been necessary to construct a completely new main road from the works towards Vereeniging. About 2 miles of this road have now been completed, and for the present the intervening distance of about 5 miles will be covered on existing roads, which have been reconditioned to make them suitable for the considerably increased traffic now to be carried. At a later date the new road will be extended eastwards towards Vereeniging, and will link up with new provincial roads which are being constructed in this area.

While the above work has been going on, the administration offices have been completed, the restaurant and trading store serving the administration staff and European and non-European employees has been built, and work is in progress on a European change house and other smaller buildings. A machinery store has also been built at the west end of the site, together with outside storage accommodation for heavier materials.

The drainage of the works area is being taken care of by the laying of a 16in. diameter main outfall drain, and storm water coming down from the higher ground to the north of the works is being deflected by a large open storm-water drain which has been cut right along the northern side of the works and which discharges to the west in the same direction as the outfall drain. A complete system of sewage disposal is also under construction to meet the requirements of the present works and of possible future extensions in this area.

Coincident with the construction of the works consideration has been given to the question of housing, first of all the construction staff, and later on the operating staff. Construction engineers were, to begin with, housed in some of the office buildings as these were completed, and for the need of the operating staff there has been established at a point about 1½ miles south of the works, a small township which when complete will consist of about eighty houses, of which thirty have already been built. The necessary water supply, power, and light supply and drainage arrangements have been provided, and transport facilities for the inhabitants of the township have been arranged.

As no works can ever hope to be entirely free of accidents, the Corporation has constructed an ambulance station in close proximity to the plate mill, which will be equipped with all modern requirements for dealing with any accidents which may happen when the works are in operation, and special provision has been made for meeting the needs of non-European members of the staff. A temporary native compound has been built to the east of the works, which is capable of housing for the present about 900 native boys who are employed on construction work at various points, and later on when the works develop as expected, there will be constructed a native location on up-to-date lines.

British Coal Utilisation Research Association

ON Wednesday, June 23rd, the new physico-chemical laboratories of the British Coal Utilisation Research Association at Combe Springs were formally opened by Sir Edward Appleton, the Secretary of the Department of Scientific and Industrial Research. In welcoming the large company of guests, Sir Evan Williams said that the laboratories had been erected to replace the premises at Fulham which had been destroyed by enemy action, and to enable important wartime programmes to be expedited. These laboratories were, he said, not the permanent home of the Association's work, for a site of some 20 acres had been acquired at Leatherhead, where the permanent home of the Association would be built. A model of the new estate was on view. Work which the Association was undertaking in collaboration with the colliery owners, the miners, and the makers of coal-burning appliances, included the design of thoroughly efficient, highly economical, convenient, and simple coal-burning grates, which were practically smokeless, and some examples of the new grates were shown in operation. Sir Evan Williams extended a warm welcome to Mr. W. Lawther, the President of the Mine Workers' Federation, and representatives of the miners who were present at the opening. He referred to the recent National Conciliation Scheme for settling all questions at issue between the colliery owners and the mine workers, which, he said, was a permanent and notable step forward. The colliery owners had also invited the mine workers to join with them in examining the many and complicated problems which must confront the industry after the war. That invitation had been accepted, and he felt that the invitation of the British Coal Utilisation Research Association to the mine workers' Federation to appoint members to serve on the Council of the Association would also be accepted. In reply, Mr. W. Lawther said that the miners were very interested in all that pertained to the future of the industry and its scientific development by research work. In declaring the laboratories open, Sir Edward Appleton congratulated the Association on its new laboratory facilities, and the financial provision which was now available for large-scale work. He stated that when the full story of the application of scientific principles to industry, as distinct from the accumulation of scientific facts, could be told after the war, it would be found second to none. In inspecting the laboratories we noted that interesting and important studies are being made of the sizing of coal, the internal structure of coal as it affects combustion problems, and the use of zircon sands from the beaches of Travancore, India, for high-temperature resisting refractories. It has been found possible to bond successfully finely divided zircon sand with other well-known refractories, and to make a zircon paint which can be applied to the surfaces of furnace linings, giving greatly increased life and freedom from corrosive action at very high temperatures.

The Engineer

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THE S.B.A.C. AND CIVIL AVIATION

A MEMORANDUM entitled "The Future of British Air Transport," issued last week by the Society of British Aircraft Constructors, deserves the attention of all the many and diversified classes of people now interested in the development of civil aviation. From the summary published elsewhere in this issue it will be gathered that the Society has decided views on the extent to which civilian flying will be practised after the war and on the manner in which its development can best be encouraged. It will also be gathered that in several respects its views are at variance with those previously expressed by a number of individuals and bodies. The Society is, of course, primarily, if not entirely, interested in the subject because of the employment which the provision of air liners will give its members. It maintains that the number of aircraft required will be large, and dissociates itself from "the sombre belief, current in some British quarters, that a very few hundred aircraft will be all that will be required to meet the needs of post-war British and Empire air transport." In support of its views on this point it relies, apparently entirely, on opinions and forecasts recently published in America. It quotes the estimate of the President of United Airlines to the effect that within ten years the United States domestic air services will be carrying 80 per cent. of the country's first-class passengers and 75 per cent. of all first-class mail moving more than 450 miles. To handle its share of this traffic United Airlines alone would require a fleet of 5250 aircraft. It also quotes a recent report of the National Resources Planning Board, in which it is stated that within the next ten or twenty years air traffic within the United States will increase 185 times from its present volume. Air mail traffic will, it is estimated, be seven times greater than it is to-day and passenger transport will reach a figure equivalent to 70 per cent. of present-day Pullman travel.

The Society expresses concern at the possibility that American aircraft firms, provided with the large domestic outlet for their products which these figures imply, will be in a very favourable position to dominate the supply of civil transport aeroplanes to foreign countries, even to this country. In order that British aircraft manufacturers may retain a fair share of the business, it proposes the taking of a number of steps—some of them now before the war is concluded—which it believes will lead to a great expansion of air transport in this country and the Empire. The outstanding recommendations which it makes include the abolition of the single State-subsidised monopoly system and its replacement by a scheme permitting free competition on a commercial basis between a number of different operators. It believes that there will be scope for the operation of eight or ten main British air line companies. These companies should not receive direct subsidies from the State, but should be aided by payment for services rendered, such as by the carriage of mails. The Society, however, obviously recognises that the companies could not prosper if the assistance of the State were confined strictly to such payments for carrying the mails. It looks to the Government to provide ground facilities, including navigational aids and meteorological information—and incidentally the construction within easy reach of London of a "super-airport" comparable with New York's existing "La Guardia" airport. The State should also, as an immediate project, undertake the work of converting heavy bombers into civil machines and later should assist financially in the development and construction of new prototype designs. On this point the Society reveals a certain tenderness of conscience. It urges strongly that "main specifications for new types of large air liners should be decided in close consultation with the [aircraft manufacturing] industry." But the State's financial aid for the construction of the new air liners should be paid to the operating companies and not to the builders, although it is possible that a "measure of financial support" might be given to the constructors to assist them with the expenses of jigging and tooling. The Society also looks to the State to finance and undertake research needed for the development of large modern transport aircraft and to assist financially the universities to meet the increased demand for trained aeronautical technicians and engineers.

It is evident that the central point of the Society's recommendations is the abolition of the existing monopolistic system. If the reader cannot guess why it desires the monopoly abolished, he will be able to find it clearly set down in one section of the memorandum. The Society, from its past experience with Imperial Airways, is convinced that a monopolistic company is sluggish in placing orders for new and improved aircraft. The Government's "single chosen instrument" policy "failed to create a substantial turnover of civil aircraft in the British industry." The Society obviously, and probably rightly, believes that the institution of free competition between a number of operators would increase the flow of orders for new aircraft to its members' works. Having decided upon the desirability of abolishing the monopoly, the Society had to face the question of subsidisation. It doubtlessly felt that a policy of paying direct subventions to half a dozen or more completely independent operating companies was not in the least likely to commend itself to the Government. At the same time, it must have recognised that without some form of external financial aid civil air transport within the foreseeable future could not become a commercial success. It therefore devised the various methods of State assistance which we have summarised above. We find it difficult to see in what fundamental respect these proposals, taken together, differ, at least from the State's point of view, from the payment of outright subventions to the operators. They cover expenditure on the very things on which the operators, if directly subsidised, would expend their subsidies. The difference between the Society's proposals and the payment of direct subsidies is not a difference of principle, but very largely merely a bookkeeping difference. For our own part we feel far less aversion to the monopolistic policy than to the policy of subsidisation. A monopolistic policy, as in this country, or a non-monopolistic policy, as in the United States, is a purely domestic question. The policy of subsidisation as practised universally before the war was dictated by considerations of national prestige and advantage and gave rise to international jealousies, distrust, and fears. We cannot see that the proposals of the British Society of Aircraft Constructors would make any material contribution towards lessening the evils and dangers of State-aided international civil aviation competition.

The Limitations of Science

THE letter by Sir Robert Pickard, Dr. Findlay, and Sir William Bragg, which we summarised in our Seven-day Journal last week, is a timely reminder that not everything is possible to science. "Many responsible scientists," said the signatories, "view with concern exaggerations which often accompany reasonable claims. From time to time statements are made by indi-

viduals or by organisations, professing to speak for science, that if some fraction of the national income were allocated to scientific research, and if men of science were given a position of authority in the affairs of State, the community would find itself in what is usually described as 'an age of plenty.'" They add that "to mislead the community as to its available resources can only foster illusions and bring disappointments which may be disastrous both for it and for science."

That popular exponents of science, and even scientists themselves, have created an unwarrantable belief in the capabilities of science cannot be denied. One of the strongest arguments in favour of the extension of scientific education is that it would check overweening faith and remove those dangerous false analogies on which it is so often founded. We dare wager that if someone asserted that a research worker had discovered the means of defying the second law of thermodynamics and that in future heat would be regularly transmitted, for the untold benefit of mankind, from cold bodies to hotter bodies, and if a scientist ventured to assert that such a process was a physical impossibility, the retort would be made that wireless and television were "impossibilities" once and that human flight was regarded as unattainable. Ludicrous arguments of that order are all too common. They are crystallised into the familiar but erroneous dictum that "nothing is impossible to science." As a matter of fact, the attainable achievements of science are very strictly limited. A great proportion of research is now, and always has been, devoted to a discovery of limitations and their formulation in the so-called "laws of Nature." Those laws prescribe quite definitely what man can do and what he can never hope to do. In engineering the thermodynamic laws are an admirable case. They define accurately the attainable efficiency of heat engines; there is no escape from them. Take he never so much thought, man can never make engines of greater efficiency than they permit. The scientist, like everyone else, is obliged to work within a framework and all that he can do is to approach ever nearer to the boundaries set up by Nature; he can never surmount them. Like a bee on a window pane, he may see vistas beyond, but, unlike the bee and credulous people, he recognises the existence of the pane and spends much of his intelligence in defining its actual position and area. When radio transmission became an accomplished fact, the public was encouraged to envisage a time when aeroplanes and ships and cars and trains would be driven by etheric waves. They did not know that radio transmission is colossally inefficient; that of all the power radiated many thousands of times the small fraction that is used is dissipated into space. Many of them even forgot that the power which operates their loud speakers or television screens has to be supplied at the set itself and is not transmitted through the ether. They may find some apology for their errors by retorting that even great scientists nod at times. How often did we hear a few years ago that the splitting of the atom would release cataclysmic forces which might not only destroy the earth, but imperil the universe itself. Since then the atom has been often split and no one is a penny the worse and not one tiny fraction of a grain the better save in the possession of more knowledge.

The charge is made in the letter from which we have quoted that individuals and organisations "professing to speak for science" are themselves responsible for the dissemination of illusions which may be "disastrous" to the community. There is some truth in that charge, for scientists in belauding their work and discoveries are not always careful to explain to popular audiences the limitations of which they themselves are aware. But more dangerous than they are those authors and speakers whose faith in science is greater than their knowledge. It is they who, as in the "blitz" of England, announce impossible discoveries and so "mislead the community as to its available resources" and by fostering illusions cause bitter disappointments. Only by spreading widely a knowledge of science and of the laws by which it is restrained can this common weakness of credulous mankind be removed. There is still endless scope for the scientists, but nothing but harm can result from the encouragement of false hopes. Faith in science must be kept within the boundaries prescribed by its laws.

Sixty Years Ago

THE "DAPHNE" DISASTER

THE mishap which occurred at the launching of the "Daphne" on the Clyde will, it is hoped, form the subject of a forthcoming article in our "Historic Accidents and Disasters" series. We shall not therefore describe it in any detail on this present occasion. She was a small screw steamer of about 500 tons, built by Alexander Stephen and Sons, of Linthouse, for the Glasgow and Londonderry Steam Packet Company. On the morning of July 3rd, 1883, she was on the ways ready for launching, with her engines—but not her boilers—in position. At about 11.30 a.m. she left the ways successfully, but had scarcely left the shore by more than her own length when she heeled over to port and sank in less than three minutes. About 200 workmen and others were on board her at the time of launching, and some 150 of them were drowned. The disaster caused much uneasiness among shipbuilders. Sir Edward Reed, late Chief Constructor of the Navy, conducted an inquiry into it. The conclusion which he reached was that the stability of the ship at light launching draught was deficient. He showed that a ship which was satisfactorily stable when fully loaded might in a light condition exhibit a stability curve, which, starting with positive values, would become negative at an angle of heel of about 50 deg., and then become positive again at an angle of about 90 deg. In those days it was not the custom to calculate the stability of a ship in the lightly loaded condition. A rule-of-thumb method of establishing the safety of a ship in her launching trim was followed. The "Daphne" disaster and Sir Edward's report upon it showed that the rule could not be trusted, and had no foundation in physical fact.

Literature

SHORT NOTICES

High-frequency Thermionic Tubes. By A. F. Harvey. London: Chapman and Hall, Ltd. 18s.—During the past twenty years the invention and investigation of thermionic tubes for dealing with waves shorter than 10 m. has gone on at an ever-increasing pace. First, tubes of the triode type were modified so that the transit time of electrons from cathode to anode was shortened, and then quite new types were devised and tested. The literature has thus become voluminous. The purpose of this book is to survey the science and practice of such tubes, at any rate within a limited range. The limitation is indicated by the author's statement in his preface that "the major portion of this book is due to the author's experimental work." This is perhaps as good a limitation as any. But we have to remember that experimenters by the dozen have made measurements on tubes of their own design or manufacture, and spread out the results for our admiration, while the theory of the electron motions has lagged far behind, with the consequence that we do not really know how things work.

The book devotes the first eighty pages to the discussion of electron motion in the triode and of oscillations generated with the negative grid. In the next hundred pages magnetrons and their circuits are similarly dealt with, and in the next forty pages the klystron and wave guides are described. The author makes a selection from the large store of matter available and does his best to make a connected story. He has produced an informative work, one that helps to guide the inquirer over the morass of experimental results already published. The book is well documented, well illustrated, and well printed.

Lubricants From Tree Stumps

IN normal times Sweden imported about 60,000 tons of lubricants a year, mainly mineral oils. Industry consumed about half of this quantity and motor traffic about one-third. Since Sweden became cut off from imports from overseas countries, a serious scarcity of lubricants has arisen which has forced her to introduce severe restrictions on consumption. While producer gas traction has solved the motor fuel problem, it is now chiefly the shortage of lubricating oils and rubber which makes it necessary to maintain and even intensify the restrictions on motor traffic. By repurifying used oils and the introduction of oil-saving devices of various kinds, an economy of existing supplies has been effected. The scarcity of mineral oils has, however, gradually increased, and the Swedish authorities have therefore had to try to evolve substitutes with which these oils could be eked out. As in so many other cases, the forest has become the auxiliary means. During the First World War the Swedish State Railways consumed about 1000 tons of lubricating oils produced from tree stumps. As a result of research in recent years it has been possible to produce lubricating oils of a fairly good quality. In 1941 a company was formed in Sweden with the object of producing tar from tree stumps. At present there are nearly 100 such plants in operation, producing about 20,000 tons of tar annually, from which it is estimated that about 6000 tons of lubricants can be obtained by means of cracking. The new products are now being put on the market unmixed or mixed to a certain extent with mineral oils.

By practical as well as laboratory tests these lubricants have been proved to possess surprisingly good qualities, although naturally they cannot be compared with mineral oils. On the whole, they can be used without inconvenience for ordinary factory machinery, railway rolling stock, and similar purposes. Even unrefined they can be used to good advantage in two-stroke engines, on account of their combustibility and because the residue is very light and porous. They are for the same reason well adapted for mixing with the fuel oil. From the crude product the Swedes are also producing drilling oils, solid grease, axle grease, leather and packing grease, impregnation oil, &c. The limitations of the tar oils would, according to the Swedish tests, seem to be that they do not satisfactorily withstand either very heavy loads or very high velocities. Being, moreover, less resistant to oxidation than mineral oils, they are not suitable for circulation lubrication at high temperatures, as in steam turbines and ordinary four-cycle combustion engines. Another weakness is that they are less resistant to cold than mineral oils. They are also expensive to produce.

From Paddle to Screw in the Navy

By FRANK C. BOWEN

IT is just a century ago, in 1843, that the Navy made the revolutionary decision to adopt the screw propeller in place of the paddle wheel and the foundations of the modern Service were laid. Steam had been introduced in the purchased paddler "Monkey" in 1821, but she and every other early steamer was regarded purely as a tug and tender, and it was not until 1828 that the influence of the Duke of Clarence (William IV) as Lord High Admiral caused the steamers to be given guns and to be regarded as men-of-war, although the paddle wheel remained essentially unsuitable for a fighting ship. It was inevitably vulnerable and lost its efficiency as the bunkers were emptied, in spite of the later ships being given iron bunkers, which could be filled with water ballast when the coal was out. As the steam warship got bigger and demanded more and more power the economic objections to the paddle were increased.

By that time there was a big fleet of paddle warships in the Service, and they were doing useful work under handicap. Originally they were all classified as sloops, but the bigger ones were popularly known as frigates, although that was, strictly speaking, limited to the ships which carried their guns on two decks. Those built from 1839 onwards varied from just under 800 tons burthen to over 1100, practically all of them carried six heavy guns and had speeds of between 9½ and 11 knots. Some of them, like the "Janus," designed by the famous Lord Cochrane, were planned on advanced lines, but most of them were very conservative in their design and differed little from the ships built in the early 'thirties.

The Admiralty fully appreciated the disadvantages of the paddle and in 1840 appointed Captain Chappell to examine and report on the performance of the experimental steamer "Archimedes," carrying Smith's screw propeller, as tried against the crack paddle steamer on the Dover mail packet service which was then run by the Navy. H.M.S. "Widgeon" had the reputation of being the fastest in that fleet and she was pitted against the "Archimedes" in several races. She proved faster by a small margin, but as she had a considerably smaller hull and a far more powerful engine, Captain Chappell reckoned that the screw was superior and its practicability proved. Her owners later put the "Archimedes" at Chappell's disposal to test the screw in the open sea and to carry out any experiments that he liked; she made a voyage completely round England and Scotland and naval officers were keenly interested in her performance. The majority considered that she had solved the problem of the steam warship, but the Admiralty refused to share their enthusiasm, and the Surveyor of the Navy, the predecessor of the present Director of Naval Construction, rejected the idea of screw warships. Pressed for a reason by the disappointed reformers, he maintained that it was obvious that no ship could be steered properly when propelled from one end, although the "Archimedes" had handled excellently and this had been fully reported to him.

In order to avoid the accusation that he was prejudiced, he caused H.M.S. "Bee" to be built at Chatham Dockyard, one of the quaintest experiments in the history of the Navy. On dimensions, 52ft. by 12ft. by 6ft. draught, she had a displacement of 40 tons, and Messrs. Maudslay, Sons and Field supplied the engine, which drove a screw and a pair of paddles simultaneously. It was a single-cylinder beam engine of 10 H.P. nominal, the piston 20in. in diameter by 24in. stroke. The paddle was of the reefing type, with floats that could be adjusted according to the ship's draught, to run at 40 revolutions with its floats just awash; the screw ran at 240 r.p.m. and was constantly being altered to try various improved types. Designed for the instruction of officers at the Naval College, Portsmouth, she spent most of her life, until a year before she was broken up in 1874, as tender to the gunnery school ship "Excellent" at Portsmouth. The experiments carried out in her for determining the value of the screw gave very varied results owing to the freak ideas tried and the lack of system and were of little value.

Of the paddle sloops, the 800-ton "Alecto," with engines of 200 nominal horsepower and an armament of six guns, had proved a good practical working ship, and quite a number of sisters were laid down. One of the last of the class was the "Ardent," which was started at Sheerness Dockyard in the spring of 1842, but in the very early stages of her construction the growing demand for a fair trial for the screw propeller and interest in the experiments with H.M.S. "Bee" overcame the opposition of Sir William Symonds, and the Admiralty issued orders that she should be lengthened aft to take a screw propeller and be renamed "Rattler." To make the trials appear as fair as possible her engines were to be of the same power and, as far as possible, of the same design as those previously used with paddles.

Apart from the fact that the engine chosen was not the best for a screw, the after lines were quite unsuitable. As completed, she had an overall length of 195ft. by 32ft. 8½in. beam by 18ft. 7½in. depth of hold, giving her a burthen tonnage of 888. Maudslay, Sons and Field supplied a four-cylinder vertical engine, 40½in. piston diameter by 48in. stroke, 200 nominal horsepower, 437 indicated. This was really a pair of the popular "Siamese" paddle engines adapted to driving a propeller shaft by means of spur gearing which multiplied the number of revolutions by four. It had been patented in 1839 in order to secure a long stroke with the very limited height available in a paddle warship, whose machinery had to be kept below the water line as far as possible. The gearing was double, the first motion, which doubled the speed, consisting of a large wheel with hardwood cogs and a smaller one with iron. The second motion consisted of a large and small drum with leather belts, which were intended as a temporary measure only, primarily to overcome the objection to the noise of ordinary gearing. It was planned to replace them later by a single-wheel pinion. Smith's Archimedean screw, as fitted in the "Archimedes," proved the most satisfactory of various makes tried. The boilers were of the ordinary flue type, and when the ship was new she carried six guns like a paddle sloop, whose battery was limited by the boxes amidships, although this was later increased to eleven—five on each broadside and a chaser.

She was launched at Sheerness Dockyard on April 13th, 1843, and the directors of the Patent Ship Propelling Company made up a large party to go down in the "Archimedes" to witness the christening of the ship based on their design; that so annoyed the Admiralty officials that they put forward the hour of launch by an hour without notice, so that the party arrived when it was all over. Her trials lasted from October, 1843, until the beginning of 1845, and, being carried out with a steadily increasing desire to do justice to the screw, they produced invaluable results. One of the first was that naval engineers realised that the propellers which had been used until then were far too long.

As a preliminary to the serious trials her paddle sister "Prometheus" had run trials on the measured mile in Long Reach in the Thames, and in February the "Rattler" ran over the same course in a condition made as similar as possible. The result was that she averaged 9·240 knots, against the paddler's 8·757. The Woodcroft screw then used was then replaced by a Smith's four-bladed Archimedean for further trials, followed by another type of Woodcroft. The results varied. At the end of June she averaged 10·074 with 428 I.H.P., not fully rigged, but ballasted down to her load draught, and after many other tests with different types of propeller the improved Smith's Archimedean was finally chosen as being the most economical and the ship was sent to sea with it.

Then followed another series of more interesting trials. Early in 1845 she raced round from Portsmouth to Pembroke against the Royal yacht "Victoria and Albert" and the Admiralty yacht "Black Eagle," both of them noted for their speed. She could not keep up with them and the results were used to the prejudice of the propeller, but nothing was published concerning the coal burned, although it soon leaked out that the yachts' consumption was colossal. The public was also kept ignorant of the fact that for part of the time the "Rattler" had a 7in. hawser and some fishing nets wound round her propeller.

In March, 1845, the famous series of trials with her paddle sister "Alecto" were started. In the preliminary run from the Nore to Yarmouth the screw ship won by 23½ minutes, in spite of the fact that boiler trouble made her very short of steam. A full gale gave the opportunity of trying the efficiency of the screw in a heavy head sea, which had been described as its weakest point, but the "Rattler" proved infinitely superior, in spite of her usual difficulty in raising steam, which was partly due to defective design preventing a free draught of air. On April 3rd the "Rattler" and "Alecto" were lashed stern to stern and the latter was allowed to work up to full speed ahead before the "Rattler" was ordered to move her engines. She gradually brought her rival to a standstill and then began to tow her stern foremost, finally working up to 2·4 knots. The trial was scarcely a scientific one, but it caught the attention of both the public and the Admiralty, and twenty-six sets of screw engines were immediately ordered. Later, when the screw engine had been proved and the paddler was making its last fight, similar trials were carried out between the screw "Niger" and the paddle "Basilisk," which produced similar results, although the "Niger" was a very inefficient type.

Various experiments were tried to make the most of the screw. Small auxiliary installations were fitted into a number of sailing ships, but it was soon decided that this was a bad policy; they were bound to be overworked and to break down. The problem of overcoming the resistance of the screw while the ship was under sail was soon settled and excellent results were obtained. The screw sloop "Encounter," of 896 tons, was built

as the equivalent of the 1100-ton paddler, and although her tonnage was later increased to 953 when she was lengthened by the stern for added efficiency, the saving was still very considerable. The broadside principle, which had been impossible with the paddler, was restored, but combined with heavy chasers fore and aft. The Admiralty got the best out of the brains of the private engineers by inviting tenders for the machinery of the new screw sloops without reference to the horse-power. The total weight of the machinery, with its auxiliaries, boiler, and water, was not to exceed 300 tons, under a heavy cash penalty, and it had to fit into the engine-room provided with a standard specification for various parts. The advocates of the paddle pleaded for a similar concession and received it, with a weight limited to 400 tons. Messrs. Seaward and Co., Maudslay, Sons and Field, Miller and Ravenhill, Penn and Co., Rennie and Robert Napier supplied this screw machinery—a considerably smaller number of firms than had secured paddle contracts. Paddle frigates were built until 1850, but their day was obviously done.

In 1844 a Royal Commission was set up to consider the coast defences of the country, and it gave due weight to the fact that the old sailing guardships would be quite useless if the coast were invaded by the numerous war steamers owned by France. A batch of two-deckers and frigates were therefore converted into blockships by fitting them with a Smith's propeller and engine and boilers of sufficient power to get the ships to windward of a force invading by sailing ships in tow. Their masts and yards were cut down to save weight and for the same purpose the seventy-four-gun ships were reduced to fifty-six guns. The speed was generally between 6 and 8 knots and the low power of the machinery gave a lot of trouble through overstrain.

Frigates and line-of-battleships, many of which had been on the stocks for many years, were given screw machinery before they were launched, not always with happy results to the ship and generally for a very modest speed. After various experiments with gearing the horizontal double-acting engine was generally adopted. On the eve of the Crimean War the conversion policy was extended to a number of ships which were already in commission, with results that were even less happy than when the work was done on the stocks. Such ships usually had a very short active life, although some existed for years as training or depôt ships, but the screw frigates, designed as such in the late 'forties, followed by the screw line-of-battleships in the early 'fifties," were infinitely superior, although in some cases there was a natural tendency to fit machinery which was more powerful than the wooden hulls could stand.

Maximum Industrial Production

At a meeting of the London Branch of the Works Management Association, held at St. Ermin's Hotel, London, on Wednesday, June 23rd, a paper on "Maximum Works Production," by Mr. J. J. Gracie, joint general manager of the Witton Works of the General Electric Company, Ltd., was discussed. Unfortunately, Mr. Gracie was too unwell to attend himself, but he was represented by Mr. S. A. Roberts, who is closely associated with him in the organisation at Witton. He put the subject before the meeting in a very able manner, and dealt with a number of the points raised, leaving it to Mr. Gracie to deal with the discussion later.

Mr. Gracie's paper opens with the suggestion that increased output of war factories is due almost entirely to an increase in the man-hours of industry, and not to any appreciable increase in the hourly productivity of those at work compared with peacetime activity. The object of his scheme is to simplify the task of management and staff and to remove the causes of low productivity by the direct worker. He attributes low productivity mainly—"far beyond any other contributory cause"—to bad rate-fixing and shows that both tight and loose rates produce the same result, *i.e.*, restricted output. What is wanted therefore is a solution to the problem of ratefixing which will "be acceptable jointly to the Government, employers, unions, and workpeople." His proposal is:—

A nationally controlled school should be established for the training of ratefixers. Its object would be to take in suitable candidates, with or without previous ratefixing experience, and give them an intensive, but thorough, course of instruction, both theoretical and practical, in scientific modern ratefixing. During and at the end of the course candidates would have to pass certain tests, and on satisfactorily completing the course they would be passed out as State Registered Ratefixers (S.R.R.s).

S.R.R.s would be capable of fixing standard times in any class of work. Clearly some specialisation would be required, so that some would be expert in engineering, others in textile work, and so on, but all would work on the same lines and to the same standards of productivity. Their object would be that all operators should achieve the same effective output of work per hour. This target would be an amount of work which the average man or woman could be expected to produce without undue fatigue for a working day of ten hours or thereabouts.

A base rate analysis should be carried out on a national scale. This means an analysis of every job performed by operators in every class of industry, so that a scale could be drawn up whereby the earning power of one job could be accurately compared with that of another. If this were done, on scientific lines (which are already well known and established), there could be no danger of anomalous rates of pay between different classes of workers, every worker being paid fairly according to the requirements of his work. This task would also be carried out by a special class of ratefixer, trained in the national school.

The operation analysis would not fix rates of pay; it would merely establish the relation between one job and another. It would be a purely comparative scale of values.

The next step would be to establish the desired level of hourly earnings for various classes of worker, at either end of the scale, *i.e.*, the highest and lowest skilled trades. These figures would be exclusive of overtime increments and national awards, but inclusive of everything else.

The earnings scale would next be related to the operation analysis scale, so that for each operation value the corresponding earnings level could be ascertained. This would fix a "target" hourly earnings figure for every kind of job.

The piece rate for a given job would then be simply the product of the standard time fixed by the ratefixer and the standard earnings rate assessed from the scales.

Piece rates fixed in this way would be impartial, fair, and accurate. If applied universally, they would remove invidious comparisons between one works and another or between one industry and another. They would eliminate unfair competition for labour. They would ensure a fair day's pay and a fair day's work.

They would also provide a quick and accurate comparison of labour utilisation and efficiency between any number of firms in the same industry or in different industries; each concern would be measurable against a definite standard. A continuous incentive would exist for all workpeople, and no limit would be set to earnings, except by the physical capacity of the individual.

All times set by a State Registered Ratefixer would be absolutely guaranteed, apart from a change in method or conditions, which would be accurately specified in every case. Earnings could be raised or lowered only by national changes in the general level of the whole earnings scale.

The remainder of the paper is devoted to a detailed examination of this proposal.

Mr. Roberts, in answer to a question, said the paper had been submitted to various public bodies, including the Ministry of Production, but just at the moment he did not think they proposed to take any action with regard to the proposals it contained. He imagined they rather felt that the proposals were made by an individual, and that before they would take any action they required the backing of a much larger body. Mr. Roberts added that he did not know whether the paper had been submitted to the trade unions.

Mr. Stone (Hoffmann Manufacturing Company) said the problem to be faced was not only lack of skilled time-study experts, but also that of providing reasonable incentive, not to the average personnel, male or female, but to the abnormally low grade of labour employed under war conditions. His own experience had been that time-study had helped materially to assist normal production operations where large numbers of semi-skilled operators were employed, but the time-study engineer's problem was to assess craft rather than actual time. For instance, in the case of grinding, the degree of finish and the inspector's requirements were very difficult indeed to assess, and only time-study engineers who had very definitely specialised in certain directions could ensure a reasonable return to the employers, who required output, and to the employees who had not had sufficient experience in the industry. The general principle of the author's scheme was admirable, but there was a specific problem involved in the very poor class of labour now being employed.

Mr. Roberts agreed with the point made, but argued that any system of piece rates based on bargaining was not to be compared with such a scheme as that proposed. The author's proposals really laid down a standard to aim at, although untrained operators might take a longer time to begin with. He understood that allowances were made during the period of training.

Mr. Gardiner (research laboratories, General Electric Company, Ltd.) suggested that the scheme should first be introduced into a Government establishment and later into some industrial concern where it might be willingly accepted. Still later it would have to stand on its own merits with other firms, who might be persuaded by curiosity to give it a trial. The advantages to the nation at present were obvious, but industry generally was in a rather artificial state at the moment, and this had brought about wages rates which, in some cases at all events, were higher than usual. With output as the main objective in wartime and the operation of E.P.T., there was less incentive to managements to keep an eye on economy. The fact was that some factories were now running on lines which normally would not be commercially economic. After the war the crucial test would be whether the scheme would be willingly accepted by industry. Any endeavour to apply it universally at once would be bound to meet with prejudice. Suggestions had already been made that a Ratefixers' Association should be formed, and although already there was a surfeit of associations, there was something to be said for an organisation requiring an adequate standard of knowledge for membership and having an organised training scheme. It would be reasonable that the Government, employers, and the trade unions should subscribe to the funds, provided none of them had any voice in matters of policy. There should be ministerial encouragement and a Royal Charter for a body relatively free from official inertia and influence, but closely in touch with industry. He agreed this might take a long time and might not lead to universal adoption at once of such a scheme as that suggested. If it could be established during wartime, so as to be able to carry on on a sure basis afterwards, effective action might be stimulated.

Mr. Roberts said personally he thought it

would take a long time to get the scheme going nationally, because of the necessity to train ratefixers to the standards proposed. He doubted very much whether a man could be regarded as anything like an efficient time-study man in less than eighteen months or two years. The scheme would have to be started on a small scale and be watched by Government officials. The administration of it was a matter upon which views were asked.

Mr. Hodge (Standard Telephones and Cables, Ltd.) suggested that a situation might arise in which a State Registered Ratefixer fixed a time in strict accordance with headquarters' standards and then a dispute arose. Would it be possible for negotiations to take place on a local basis between the shop stewards and the representatives of the ratefixers? In such an event, headquarters' standards might be upset. On the other hand, once the State Registered Ratefixer had made a decision, would everybody be expected to stand by it? There was the possibility of management having different views from the ratefixer.

Mr. Roberts expressed the view that standards from any headquarters' establishment would have to be accepted as a guide only. The essential was that the approach to the subject should be the same throughout all industry. Conditions in various factories and processes varied enormously, and great care would have to be exercised in applying any headquarters' standard. There were such matters as the physical condition of the material, the nature of the cutting tools, assembly work and inspection, heating and ventilation, &c. One requisite was that the ratefixers would have to be trained to show the operator that the job could be done in a certain time in a certain way. The right type of man for this would have to be selected.

Mr. Gordon (Standard Telephones and Cables, Ltd.) said that as a ratefixer he challenged the suggestion that war production was being held up by ratefixers. If there was any holding up it was due to a number of causes. He believed such a scheme would be up against a host of difficulties in peacetime, especially if it were applied first under war conditions with war labour and war machines which the ratefixer now had to make the best of.

Mr. Roberts said that Mr. Gracie had not lost sight of the fact that there were other difficulties which were holding up war production, and added that he believed Mr. Gordon's method of ratefixing was something on the lines suggested in the paper.

A number of other speakers took part in the discussion, and one expressed surprise that Mr. Gracie should advocate even more Government control, having regard to the views being expressed so widely that bureaucratic control should disappear as soon as possible. He did not think further Government control would be welcomed by industry as a whole. Another view was that bargaining between the unions and employers would be necessary before the present system of piece rates was likely to be abolished. The question as to how the time-worker fitted into this scheme was also mentioned, and it was also asked who was to control it. One speaker recommended the factory inspectorate, as a disinterested body, assuming, he added, the scheme was ever put into operation.

Finally, there was criticism of the suggested term "State Registered Ratefixers," and "planning engineers," "time study engineers," or some similar title was proposed as more dignified. Mr. Roberts' answer was that in some cases the application of the scheme might not be to engineering, but to office methods, for example

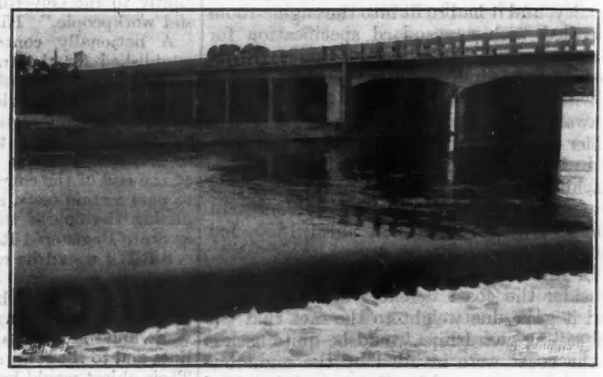
Tiburcio Benegas Dam, Argentina

MANY years ago there was built across the River Tunuyan, Mendoza Province, in Argentina, the Medrano dam, whose purpose was to divert the waters of the river into two canals, one on each bank, the San Martin and Reduccion, which are responsible for irrigating 41,000 and 12,500 hectares of land respectively. This dam—it amounted, as will be seen from the first engraving, to little more than a weir—was 2 m. high and 233 m. long. Five small discharge chutes were provided. Much trouble was encountered from the blocking of the chutes with flotsam, and it was found difficult to prevent sand and silt from entering the canals.

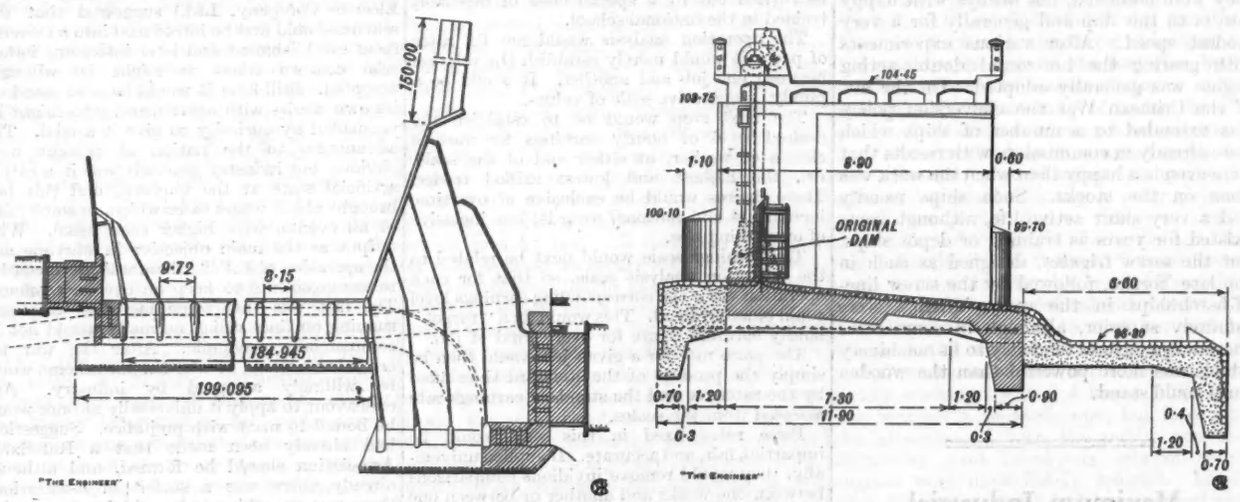
The dam has now been rebuilt in the form of a barrage with sluice gates and efficient means of trapping the sand and silt have been incorporated in the design. More complete utilisation of water flowing down the river in times of flood has been made possible, with the result that the capacity of the San Martin canal has been raised from 45 to 60 cubic metres per second. As a result it is hoped substantially to increase the area irrigated by the canal, while at the same time, owing to the virtual elimination of the inflow of sand and silt, the upkeep costs of the canal will be reduced.

The new dam, now known as the Tiburcio Benegas control dam, in addition to its hydraulic function, carries a highway bridge across the river.

The accompanying engravings illustrate the old and the new structures, whilst a drawing shows its construction and dimensions.



THE TIBURCIO BENEGAS DAM BEFORE AND AFTER REBUILDING



PLAN AND SECTION OF DAM AS REBUILT

Aluminium in Post-War Reconstruction

By ROLT HAMMOND, A.C.G.I., Assoc. M. Inst. CE..

No. I

PROGRESS in light alloy engineering promises to take a great leap forward after the war, mainly as a result of the tremendous stimulus imparted to it by war demands. Aluminium will play a leading part in this development, for the alloys of that metal are some of the most successful known to engineering science and it is possible that further research will reveal new ways in which these alloys can be used.

The price of aluminium will obviously be the dominating factor in determining its future employment on a large scale. At present the price is controlled, but is still about £16 per ton above the pre-war level, and can give us no guide to future trends. It is significant, however, that in the United States there has been a 25 per cent. reduction in price since September, 1939. It would appear that this price is likely to touch even lower levels in the future, in view of the vast increase in productive capacity and the abundance of electric power available for supplying the heavy current demand of electric refining furnaces.

The element aluminium is found in most of the clays, of which there are almost inexhaustible deposits in the world, but the extraction of aluminium from clay is an extremely difficult process. Bauxite is almost the only aluminium-bearing ore which can be worked economically, but even here complex chemical processes are involved for separating the iron and silicon oxides from the aluminium oxide. Subsequent electrolysis is found to consume as much carbon electrode as metal produced, in addition to about 23,000 kWh of electrical energy per ton of aluminium.

It should be emphasised that the price of the virgin metal is but one factor of many influencing the final cost of the finished product, since the production of alloys by extrusion, forging, and rolling is an expensive item; little reduction in the latter can be expected in the future, the greater part of the cost comprising labour charges and maintenance of the very heavy plant involved. As against this, however, a generation is now growing up skilled in working light alloys, a vital factor in reducing the cost of the finished product to the consumer. In all post-war planning it will therefore be essential to take full account of the probable trend in price of aluminium, lower prices opening up new markets hitherto closed for economic reasons.

World capacity for the production of aluminium may well be at least six times that recorded in 1939 at the end of this war. It is also believed that stocks of both virgin and secondary metal in this country and throughout the world, in addition to the scrap accumulated in the United Kingdom from obsolescent war material, will equal domestic production of the virgin metal for some years to come.

In his presidential report for 1942 Mr. Roy A. Hunt stated that the Aluminium Company of America produced 1,000,000,000 lb. of aluminium during the year, or 63 per cent. more than the world output for 1938. The current rate of production is said to be greater than that of all the Axis-controlled countries of Europe, and probably eight times that of Japan. The future production will probably exceed any possible output of all our enemies combined.

Furthermore, Mr. Hunt emphasised that manufacturing facilities have kept pace with production of the metal. The company now forges twice as much aluminium as it did before the war. Its output of castings has been multiplied eleven-fold, and the manufacture of tubing and extruded sections nine times. A single mill now turns out one and a half times as much aluminium alloy sheet for aircraft as the United States used during the entire year preceding their entry into the war.

Some further interesting facts relating to aluminium production in the United States were disclosed by Mr. T. D. Jolly, chief engineer and director of purchases for the Aluminium Company of America, in an address which he gave to the National Association of Purchasing Agents in New York recently. By the end of this year it is anticipated that the United States will produce approximately 6½ times the production of 1939, or about 900,000 tons. Mr. Jolly pointed out that the production of 1 lb. of aluminium requires 2 lb. of alumina derived from 4 lb. of bauxite; furthermore, 10 kWh of electrical energy are required to separate the aluminium from the oxygen and 3 lb. to 4 lb. of carbon electrode is consumed.

Bauxite contains about 55 per cent. of hydrated aluminium oxide and impurities in the form of the oxides of iron, silicon, and titanium. The bauxite having been ground to a fine powder is digested in hot caustic solution under pressure. Aluminium hydrate is dissolved in the liquor and passes with it through a filter press, leaving a residue known as "red mud," the remainder of the bauxite, which goes to waste. The liquor, after cooling, enters large tanks, where aluminium hydrate is precipated. This is washed to remove soda, thickened, calcined, and sent to reduction plants as alumina; the ore-refining process requires large quantities of water, soda ash, and lime.

Reduction of alumina to metallic aluminium is carried out in electrolytic cells, each comprising a steel shell lined with carbon, which serves as a cathode. Electric current is led into each cell through carbon anodes suspended in the form of bus-bars above the cells. In the electrolytic cell, aluminium oxide dissolved in a bath of molten cryolite is decomposed by the passage of electric current. Cryolite, so far as the United States is concerned, has hitherto been imported from Greenland, but Mr. Jolly described how a synthetic equivalent has now been developed in the States. At present, additional electrolytic plants are being built to make the country independent of imported cryolite.

When the bath material has been melted by the current, alumina is added, employing direct current of low voltage, which separates the aluminium oxide into aluminium and oxygen. The latter combines with the carbon anode to form gas, which escapes, aluminium being deposited on the bottom of the cell, whence it is tapped off.

This brief description of the production process has been included in order to emphasise its somewhat complicated nature and to explain in part the reason for the relatively high price of the metal. Mr. Jolly estimates that the production desired in the States will require annually more electric current than was consumed in 1940 in twenty-seven of the forty-eight States in the country; more in one day than for a city of 60,000 homes in one year. At the end of the war this enormous productive capacity should obviously be used to the best advantage of industry.

Although it is almost impossible in these uncertain times to forecast the comparative prices of such materials as duralumin and structural steel, a rough approximation may be arrived at by considering that before the war the unit cost of duralumin was about fifteen times that of structural steel. Specific gravity of the latter being more than three times that of the former, we find that the volume-for-volume ratio of cost is about 5 to 1.

From an economic standpoint, the strength-weight ratio is a matter of vital importance, and this hinges very largely on the method of loading. For example, the tensile strength of duralumin may be taken as 25 tons per square inch, as against 28 tons per square inch for structural steel. In tension, a duralumin member need have a cross-sectional area only some 12 per cent. larger than that required for a steel member of the same strength; since relative specific gravities are as 2·79 is to 7·8, a duralumin rod would thus weigh a mere 40 per cent. of its steel counterpart, and similar comparisons apply to short compression members.

In considering a long slender column, failure occurs at a buckling load determined by applying the Euler formula. Here the important factor is the "slenderness ratio," or ratio of unsupported length to least radius of gyration. For duralumin it is found that the buckling load is only one-third that of a steel column of similar size and cross section. It has been proved, however, that if we multiply the linear dimensions of the cross section of a duralumin strut by 1·31 it will withstand the same ultimate load as a steel strut. This assumes that in each case failure will be due to buckling. Duralumin loaded as a beam or cantilever must have dimensions about 4 per cent. larger than those of an equivalent steel beam. The weight of the duralumin beam would amount to about 39 per cent. that of a steel beam.

It is obvious, of course, that the high strength-weight ratio of aluminium is a factor of vital importance in aircraft, and in any moving machinery where reduction of dead load means a corresponding reduction in power demand. Reduced operating costs result in reduced wear and tear. As a corollary, manufacturing costs are reduced, owing to lower handling charges. Where one man can lift an aluminium casting, three men might be required for an equivalent steel casting. An ultimate tensile strength in excess of 30 tons per square inch is quite usual in heat-treated aluminium alloys, with the result that they can compete on even terms with alternative materials in so far as mechanical strength is concerned.

Some indication of the far-reaching advances recently achieved in the manufacturing technique of these alloys may be gained from the great increase in the size and capacity of modern extrusion presses. For example, the Aluminium Union has in operation a 5000-ton press, capable of extruding billets for forging or other purposes to a maximum weight of nearly half a ton and having a maximum cross-sectional diameter of about 16in. With this machine it is feasible to produce special angles, channels, and other sections in heat-treated high-strength alloys up to a maximum length of 70ft.

Warrington[1] has described the largest extrusion press in this country at the works of the Reynolds Tube Company. This exerts a pressure of 6000 tons and has a container 20in. in diameter and 48in. long. He has stated that it should be possible to produce an extrusion of small cross section from this press to a maximum length of 80ft.

After the war we may well see the employment of aluminium alloys on a large scale in the construction of long-span bridges, both of the arch and suspension types. A bridge requires at least five-sixths of its strength with which to support its own weight, thus leaving less than 20 per cent. free for carrying live load. Heat-treated aluminium alloys can carry greater loads per unit of their own weight than any other material with correspondingly greater structural rigidity. In America we have two outstanding examples of the use of aluminium in large structures—the reconstruction of the Smithfield Bridge in Pittsburgh[2] and the Covington Cincinnati Bridge.

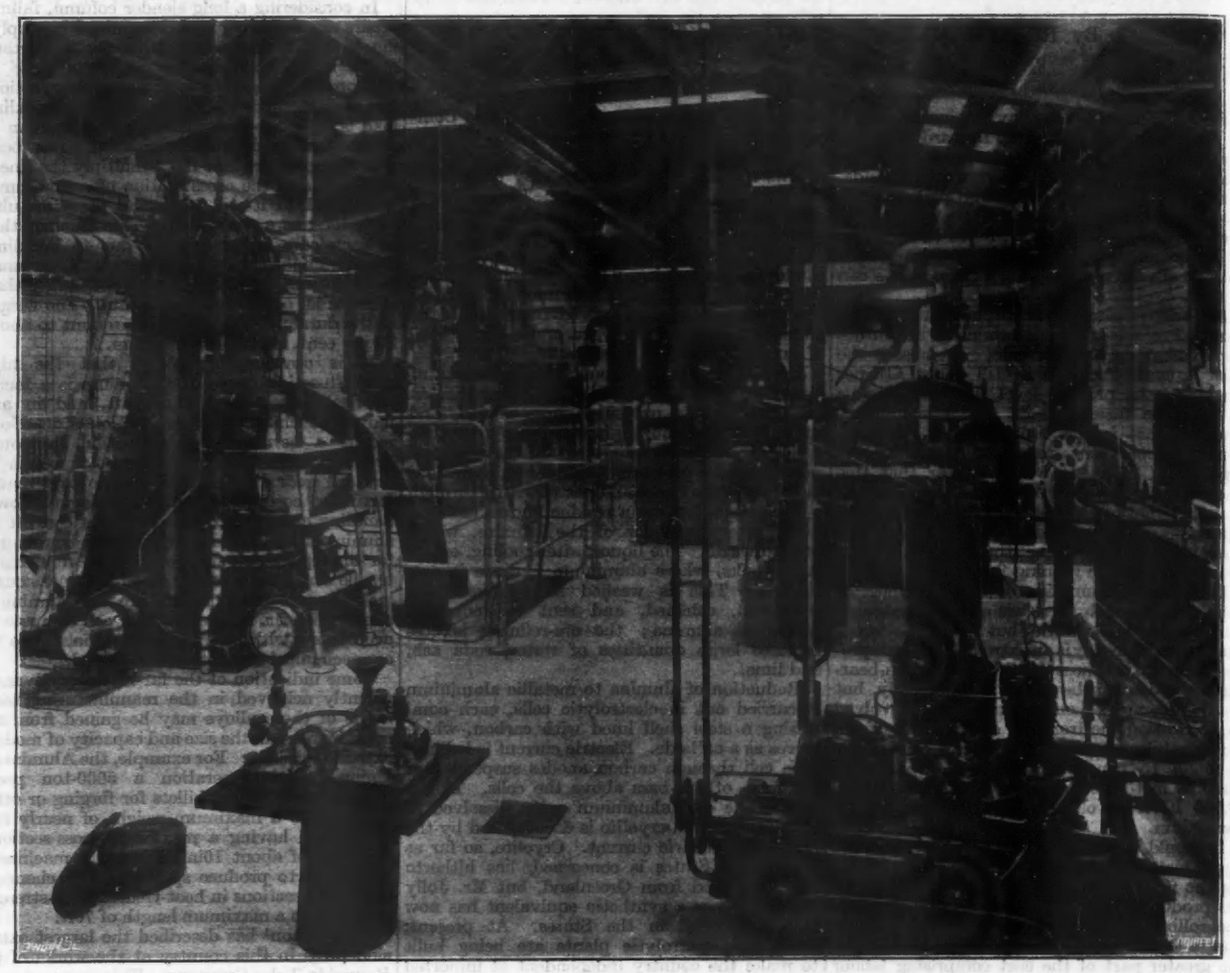
Although the former work has already been fully described and illustrated in these columns, a brief description may not be out of place here, in view of its significance in relation to possible future developments. Here we have an instance of an old bridge having become obsolete through old age and the greatly increased load which it was called upon to carry. The engineers were thus faced with two alternatives, namely, to demolish and rebuild the bridge or to reduce deadweight down to that limit at which an increased live load could be carried. The problem was solved by substituting a floor system of aluminium alloy for the original structure of steel and timber, resulting in a saving of weight of 751 tons.

Built in 1882, the bridge comprises two

[1] "The Use of Light Alloys in Structural Design," by W. C. Devereux, F.R. Ae. S., Vol. XXXII of the "Proceedings" of the Institution of Automobile Engineers.

[2] See THE ENGINEER for July 27th, 1934.

ENGINEERING LABORATORY, STOW COLLEGE, GLASGOW



360ft. spans and approach spans. Cost of building the new aluminium floor amounted to not more than a quarter of the estimated cost of a new bridge. It supports a double tramway track, a 22ft. vehicular road, and a 12ft. pathway on each side of the bridge for pedestrians. A greater degree of shop assembly was possible with aluminium than would have been feasible with structural steel.

This structure is believed to be the largest yet constructed in aluminium alloy, but a significant pointer to possible future developments is provided by the fact that practically every footbridge built in New York in recent years has been in aluminium alloy.[3]

In the case of the Covington-Cincinnati Bridge certain structural parts were replaced by aluminium, and 609 aluminium panels for the walkway were fabricated by spot welding aluminium channels to corrugated aluminium sheet. Welding of prefabricated units under controlled conditions in a factory has made great headway recently and offers many outstanding advantages. It is unlikely, however, that site welding will be employed on long-span aluminium bridges until more suitable welding procedure has been devised, and adequate proof provided that it shows substantial advantages over the existing methods of riveting. Welding aluminium entails a much higher standard of control than is the case with steel.

(To be continued)

THE "TYPHOON" DIVE BOMBER.—The Hawker "Typhoon" single-seater fighter, illustrated in our issue of May 7th, is now being used as a dive bomber. It is fitted to carry two 500 lb. bombs.

[3] Paper read before the Scottish Branch of the Institution of Structural Engineers by Edgar T. Fainton, B.Sc., in 1935.

Marine Engineering Laboratory, Stow College, Glasgow

FOR the training of marine engineers and also of cadets studying for entry to the Royal Electrical and Mechanical Engineers, the Education Committee of Glasgow Corporation has established a new laboratory at Stow College, School of Engineering, one of the Education Department's schools. Attendance and training in this school, we are informed, will be accepted by the Ministry of War Transport in lieu of qualifying service afloat. The laboratory is practically self-contained, housing within its four walls a Diesel and a gas engine, a refrigeration plant, steam engines, steam boiler plant, and an electrical sub-station.

The Diesel engine, which has been lent by Mirrlees, Bickerton and Day, was the third one to be built in this country, fully forty-one years ago. This unit, when running at 190 r.p.m., develops 35 B.H.P. in a single cylinder. Starting from cold is carried through by compressed air and the air bottles are recharged by the engine when running. For laboratory testing purposes a standard brake drum is fitted, and complete facilities are available for taking indicator diagrams, fuel feed, and circulating water data. A small gas engine forms part of the equipment and was installed for the benefit mainly of the Royal Electrical and Mechanical Engineer cadets and other engineering students. It is a single-cylinder 10 H.P. gas engine fitted with low-tension ignition. This unit has been arranged with complete testing equipment, the method of loading being by means of a brake drum.

The steam engine equipment consists of three units, which occupy about one-half of the laboratory engine space. One of these engines is a horizontal single-cylinder 10 H.P. unit, running at 200 r.p.m., with slide valve operation and centrifugal throttle type speed governor. The loading is obtained by brake drum and the engine is fitted with indicating gear and arranged to run in conjunction with a condenser, so that full brake horsepower and steam consumption tests can be made. A second horizontal engine, presented by the Saracen Foundry, Ltd., of Glasgow, is a unit of 30 H.P., running at 100 r.p.m., and drives by belt from the fly-wheel a 25-kW, 25-volt D.C. generator. The connections from this generator are taken to a bank of immersion heaters fitted in a hot water calorifier. This method permits of varying loads being placed on the set by simply switching on one or more heaters. At the same time, a useful purpose is served in that the hot water so obtained is employed in the college buildings. The third steam unit is a high-speed vertical engine, presented by J. Howden and Co., Ltd. It is of the enclosed type with forced lubrication and runs at a speed of 600 r.p.m. Brake drum loading is employed.

The equipment also includes a small refrigeration unit, presented by L. Sterne and Co., Ltd. It is a standard unit of the methyl chloride type, motor driven, and is equipped with instruments to enable tests for the coefficient of performance to be made.

The boiler plant comprises three electrode boilers, manufactured by Bastian and Allen, Ltd. No other type of boiler could have been accommodated in the space available and, in addition, only an electrode boiler, it is held, could give the immediate response called for in an installation of this nature. Normally, the boilers are left completely empty, and when steam is wanted the push-button control on the boiler feed pump is operated and in a few

minutes the boiler, or boilers, will be ready to take the engine loads for one, two, or all three units. The electrical supply for the boilers, two of which are each rated at 350 kW, and the third at 150 kW, is obtained from a nearby sub-station and is controlled from a switchboard comprising a main isolating circuit breaker and three outgoing feeder control circuit breakers, one for each unit. Each boiler has its own feed pump, but all three are so interconnected that any pump can be arranged to feed into any boiler. Similarly, the steam outlets from all three units are taken to a common header, so arranged that any boiler can supply either of the three engines, or all three engines may be supplied from the common combined boiler capacity.

The lighting equipment, of the fluorescent type, is of the General Electric Company's manufacture and has a total loading of 2¼ kW. In addition, with so many rotating parts in the laboratory, an emergency lighting system of six lighting points has been installed. Whenever the laboratory is in use these lights are always on and obtain their supply from a battery in the College.

National Research

ADDRESSING the Parliamentary and Scientific Committee, on June 1st, Sir Stafford Cripps said that in some of our industries there existed a dangerous habit of relying upon the research of other countries. In many cases before the war manufacturing firms in this country were relying on German or American research and were, in fact, merely exploiting foreign-owned patents and inventions in this market or the Colonial markets. The "research content" of the price, therefore, was devoted through royalties and other payments to maintaining research abroad instead of stimulating our own native efforts in that particular field, and as a result we found ourselves at the beginning of the war very deficient in this respect in a number of essential industries.

What was required was to increase the volume of our research, both basic and applied, and, at the same time, to introduce some measure of planning so as to make the best use of our available resources. We must also decide through what agencies we wanted this research to be carried out and how much of our national wealth we were prepared to devote to the research itself as well as to the provision of the personnel for research, technical development, and production engineering.

In his view, privately run research institutions were not quite the same thing as nationally organised institutions. They had not quite the same functions. There were two important differences from the national point of view. First of all, these private industrial research institutions were apt to be partial and specialised in their application. That arose from the very nature of their organisation. And secondly, they depended for the volume of their work upon the prosperity or otherwise of the industry with which they were specially connected. That did not mean that they were in themselves a bad thing, but it did mean that they needed supplementing by some national research institutions. These institutions were, of course, very elaborate and very expensive matters, and many industries just could not afford to set up adequate research laboratories of their own. Indeed, the number of such really complete institutes was comparatively small. A case in point was the erection of wind tunnels in this country and their enormous cost. No firm to-day of aircraft manufacturers had the resources—in this country—to set up a really first-class institution for aeronautical research, and it was this sort of gap which the State Research Service must fill.

He regarded the question of status as a most important one in connection with the obtaining and retaining of personnel, and it was time that we had a State Scientific Service apart from, but on a parallel with, our administrative Civil Service. He believed that such a service should be under the control of a single responsible Minister, so that he could draw together all the threads of scientific endeavour so far as the State was concerned. But the actual administration of the research itself should, he thought, be under a body of scientists similar, perhaps, to the Academy of Sciences in Soviet Russia, or to the Academia Sinica in China, and it should be their task to decide upon the classes of research institutes that required to be set up and also upon what broad lines the research should be carried out and planned, leaving a very large measure of local control to the actual head of the institute itself. It might possibly be that the Royal Society could perform that function if it had a special administrative staff for the purpose. It was most desirable that it should be left to scientists to decide these matters, though, technically, their decisions would, of course, have to be in the form of advice, because the Minister responsible for the expenditure would have to have the ultimate decision in order that he might be accountable to Parliament for the use that was made of the money.

Such a development was nothing more than a natural growth out of the present rather muddled system as it existed. He felt that the moment had arrived for the introduction of a consolidating and amending Bill (to use a parliamentary phrase) to deal with this whole question and to correlate it with the work of the universities and the industrial research institutions. He believed that the question of status, of salaries of research workers, and scientific staffs must be put on a proper basis to attract and keep the best men. As to the amount of money which had to be spent in the future, if one examined the position in 1938–39, it was impossible to arrive at any even approximately accurate estimate of the total expenditure upon research, because there was no such figure obtainable. The expenditure of the Government was a comparatively small item—not more than £1 million or £2 million at the most. The actual expenditure of the D.S.I.R. was £872,000, of which £146,000 was in the form of grants to industrial research institutions and £26,000 as grants to students. Then there was a really ridiculous sum of £12,000 to the Royal Society for the purpose of encouraging research! There was a Treasury grant to universities of £2,730,000. The only estimate of the general volume was one by Professor Bernal, where he said the total amounted to less than one-tenth of 1 per cent. of our national income. And if we took the comparable figure which was available for the Soviet Union in 1934, a thousand million roubles was spent upon research institutions, equivalent to 1 per cent. of the national income, or about ten times the amount estimated for this country. The estimate for the United States came out at the same figure—ten times the amount expended in this country, or three dollars per head of the population.

It was quite clear, therefore, that the amount of our pre-war effort was very much less than was needed and was much less than the other great industrial countries, including Germany. We must envisage spending at least ten times as much after the war if we were to make headway or even to keep abreast in any of the industries, such as the light chemical, optics, radio, civil aviation, as well as of the heavier industries.

The Future of British Air Transport

WE reproduce below the official summary of a report on the Future of British Air Transport, issued on June 25th by the Society of British Aircraft Constructors. The report is discussed in a leading article in this issue.

The Society of British Aircraft Constructors, which has been the representative body of the British aircraft industry since 1916, places on record in the attached memorandum its considered views on the development of British commercial air transport. These may be summarised as follows:—(1) There will be a large post-war field for air transport operation; (2) Great Britain and the Empire must take a leading part in that development, comparable with that Great Britain has taken in shipping; (3) British-designed and British-built transport aeroplanes must be used on world air routes.

On the post-war international control of air transport the Society declares:—(*a*) That within a framework devised to prevent armed aggression there should be as much freedom of operation as possible. (*b*) That abolition of the single State-subsidised monopoly system and substitution of a system whereby commercial requirements come uppermost would enable operation of air transport for commercial and economic needs and not for reasons of security, prestige, veiled military development, and strategical requirements. (*c*) That State aid to operators should be given in the form of payment for services rendered—say, for the carriage of mails—and not as direct payment by the State. (*d*) That ground facilities, including navigational aids, meteorological information, and provision for technical landings *en route*, should be the liability of States flown over by international air line operators. (*e*) That the right to operate international air lines might be restricted to those companies which submitted their operations to full audit and control, and to the regular and frequent publication of the results of such operations. (*f*) That the intervention of Governments in technical matters should be limited by the establishment of bodies to supervise airworthiness requirements similar to the Air Registration Board set up in Great Britain.

The Society suggests immediate action on the following points which can be decided without waiting for final consultation with those of the United Nations who are not represented in the British Commonwealth:—(i) Establishment of a complete understanding with the Dominions, including decision as to the future home of Commonwealth research, with the object of ensuring maintenance of a technical standard at least equal to that of the United States and the Soviet Union. (ii) Immediate Governmental decision on the future ministerial control of civil aviation, whether the Air Ministry, the Ministry of War Transport, or a new Ministry of Civil Aviation. (iii) Abolition of the "single chosen instrument" policy to avoid the evils of monopoly and to ensure vigorous development of Commonwealth and world airways and the highest level of technical development of British transport aircraft. (iv) Immediate large-scale production of British air transporters derived from conversion of existing British heavy bomber aircraft. (v) Provision of prototypes of new commercial aircraft, as a short-term policy, by direct subvention for that purpose of reputable potential British operators of Empire and world air routes. (vi) Provision with State aid of the larger and more costly apparatus of research needed to cope with the growing size and complexity of modern transport aeroplanes. (vii) Encouragement at universities and in the industry of schemes designed to provide Great Britain and the Empire with an adequate and continuing supply of technicians, engineers, and skilled mechanics. (viii) Immediate review of airport facilities in Great Britain and the Empire, with the object of providing the most efficient ground organisation for civil air transport; and, in particular, the immediate adoption of measures to provide Great Britain with at least one super-airport as soon as possible after the war. (ix) Decision on the licensing of internal air services, which should be conducted on lines similar to those governing road transport and directed to encourage the operation of efficient and economical services and to ensure safe and regular operation. (x) Provision for full interchange of operational data and experience, at home as well as abroad.

Finally, the Society stresses that on these issues, which so vitally affect the aircraft designer, constructor, and operator, there should be close consultation between the Government and industry before far-reaching decisions are taken. In civil aviation the views of the industry have gone unheeded since the last war, with adverse results to British air transport and the British aircraft industry which are now clearly apparent.

Faster Cargo Liners

IN writing in our issues of May 7th and 14th regarding recent developments in British shipbuilding and marine engineering, we made mention of the increasing number of faster cargo liners and tankers which were now being built for private and Government account. Some of these ships were seen under construction, and oil engine and steam turbine machinery which will be used to propel them was also inspected. For some of these ships electric propulsion is to be employed.

In the accompanying illustration we show one of these new faster cargo liners ready for launching. The photograph is a somewhat unusual one, since during a recent heavy gale the scaffolding which usually surrounds the hull of a ship during its construction was blown down by the wind. The absence of the scaffolding allows the clean lines of the hull shape to be seen and the looped drag chains for retarding the ship after launching. No time is being lost in pressing forward with the construction of these faster cargo ships, which will form an important part of the production of British ships during the present year.

CARGO LINER READY FOR LAUNCHING

South African Engineering Notes

(By our South African Correspondent)

Industry After the War

General Smuts has outlined far-reaching plans the Government is preparing for facilitating the change-over to peace conditions after the war and for "raising the whole standard of society." After emphasising the importance of the Industrial Development Corporation, he said instructions had been given to the National Supplies Council under Dr. H. J. van der Bijl to make an immediate survey of what steps would be necessary to switch from war to peace industry. Instructions, he said, had also been given to all Government Departments to work out in as full detail as possible the programme they had ahead of them. A committee of the Social and Economic Planning Council had been appointed to consider the various schemes put forward and to frame a programme for submission to the Government. "More than social security is required," said General Smuts. "What we want is not only social security, but the raising of the whole standard of society." General Smuts also spoke on the Nutrition Council, the Central Housing Board, the Health Commission, &c.

Agricultural Implements and Machinery

The demand for agricultural implements and machinery has been much less this year than last, and the efforts made by engineering firms to manufacture some lines in the Union are helping to save a famine. Ploughs are exceedingly scarce, and so a number are being fabricated. The Iscor steel works is doing much to help the farming community. The works have been especially helpful in regard to baling wire, of which it has supplied a considerable tonnage, and the Controller has congratulated Iscor on overcoming manufacturing difficulties and says that most of the plant required for the enterprise was made in South Africa. It will still, however, be necessary for farmers to exercise the greatest economy in the use of the wire, as the Iscor production is limited.

Congo Steel

Details of new naval and industrial works recently erected in Leopoldville, Belgian Congo, were given by a visitor to the Union during March. He states that there is a large block of steel works with a 5-ton rolling mill, a furnace capable of treating bronze and aluminium, an electric furnace which will produce 35 tons of steel a month, and moulding apparatus. There is also a large workshop all ready equipped with many machines and awaiting precision machinery. A large forge has been erected capable of producing daily 5000 tools, such as spades, axes, &c. A factory producing tins and another for bottles are also among these new installations which, it is hoped, will produce most, if not all, of the Congo's needs.

Coal and Metal Production Rising

The production of coal, the Minister of Mines said recently, was increasing and there was plenty of coking coal in the Union. The production of iron and ferro-alloys was continuing successfully. A first casting of ferro-tungsten had been very successful. Copper was being produced in increasing quantities. In 1939 the output was 14,734 tons, in 1942 it was 30,802 tons. The production of mercury in the Murchison Range reached 573 75-lb. flasks last year, and it was expected that 1000 flasks would be obtained this year. In 1939 no mercury was obtained in the Union. The production of chrome ore and manganese had been restricted owing to shortage of freight to America. The Mines Department received information that there was tin in the Koakoveld and an expedition was sent out. The tin was found and the deposits proved to be very rich. In December production was 6 tons and in January 8½ tons, while 6½ tons were recovered in February. Production is continuing. Research work and investigation into mineral oil prospects are being continued. With regard to industrial diamonds, Mr. R. Lund, Chief of the Miscellaneous Metals Section of the U.S. War Production Board, has told a Senate Committee that demands for industrial diamonds have, up to now, been met chiefly by South Africa. He added that expansion in production in South Africa might be necessary. Corundum was only imported from South Africa, but American deposits might be developed to supply 10 per cent. of requirements.

Rand's £20 Million Post-war Schemes

The Johannesburg City Council is now considering post-war schemes to the value of about £20 millions. The proposal by the Native Affairs Committee to build 20,000 houses for non-Europeans at an estimated cost of £10 million accounts for half of the programme. At the end of January this year the Council submitted a scheme to the Government and the Provincial Council, urging the expropriation of Alexandra township. This was estimated to cost £3,025,000, and the proposal is that each of the three parties should share the cost.

By last June the Finance Committee had drawn up a list of post-war schemes which were estimated to cost about £6,400,000, and that has since been added to. The items in that programme included roads, drainage, and sewerage, £1,000,000; European housing, £1,426,600; coloured housing, £165,000; native housing, £688,500; electricity extensions, £769,000; purchase of trolleybuses and equipment, £716,000; public health requirements, £256,000; new City Treasury Department, £425,000; and developments in connection with the public parks, £668,000. The total figure does not take into account several land purchase schemes which have been under discussion for some years, the proposed reclamation of the western areas of Johannesburg, the development of Kazerne when it is handed over to the city, the demolition of the old post office in Rissik Street, and the laying out of a new scheme there, and many other projects. The Council is anxious that the Government should share in the financing of schemes which are held to be of national advantage. All the schemes would come out of capital expenditure and large loans would have to be raised either by the Government or the Council to finance them. At present interest and redemption on £1,000,000 is about £55,000 per annum.

New Transport Authorities

The establishment of a National Road Transportation Advisory Committee and a National Road Transportation Council is announced in a statement by the Minister of Railways as a result of the recent conferences on the rationalisation of transport with a view to the conserving of supplies of vehicles, spares, rubber, oil, and petrol. The whole aim of the Government behind this rationalisation scheme is to ensure that the interests of the public in general in the vital matter of transportation facilities are safeguarded, and that at no time during the period of the war will there be a complete breakdown of transport facilities, as may easily occur if the conservation of supplies is not taken in hand and controlled at once. Stricter control is envisaged and will include the elimination of cross deliveries by merchants, manufacturers, and others; the introduction of bus feeder services to the trams and railways, and other matters. The Advisory Committee will consist of the four controllers and representatives of interested bodies, including road operators. The Council will consist of a chairman and not more than four members. Local panels may be appointed.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

Iron and Steel in the United States

The trouble with the coal miners in the United States has created somewhat uncertain conditions in the iron and steel trades there. Blast-furnace operations have not been fully maintained, and at one time about a dozen blast-furnaces in the Pittsburgh and the Eastern Ohio areas were closed down indefinitely by orders of the managements. The calling of a trade truce and the orders by the mining officials of the men to resume operations coincided with these instructions, but as a result for four or five days a number of furnaces were idle. Production was afterwards resumed, but irregular production appears to have followed the cessation of the truce on June 20th. It is expected that the blast-furnace capacity of the United States will be increased early in 1944 to 71,287,000 tons annually. This is contingent upon the completion of the building programme now in hand. The production will include 10,000,000 tons of ferro-alloy and merchants' pig iron and 61,287,000 tons of steel-making iron. The building programme includes the building of twenty-one entirely new blast-furnaces and the reconstructions of about half a dozen which have been inactive or partially inactive. It is expected that the production of steel in 1944 will reach 97,656,000 tons (ingot capacity). The estimated capacity includes 84,788,000 tons of open-hearth steel, 6,553,000 tons of Bessemer, and 6,315,000 tons of electric furnace steel ingots. Largely due to the miners' strike, production in the United States fell in the middle of June to 97·5 per cent. of capacity per week from 98·4 per cent. This was equivalent to a weekly tonnage of 1,688,400 tons. The demand for steel plates is similar in the United States to that ruling in this country, and great efforts are being made to maintain and increase outputs. Deliveries of steel plates from all sources, including strip mills converted to the rolling of ship plates, were stated recently by the War Production Board to be satisfactory.

Pig Iron Market

There is a heavy consumption of pig iron. The engineering foundries and most of the iron-foundries are fully employed on producing castings for firms engaged on armament work. A large tonnage of castings is being provided for the war industries, but the production of pig iron is maintained on a scale sufficient to meet essential requirements. The situation in the hematite pig iron department has not yet improved and distribution is carefully supervised. Hematite is not released for any purpose for which other descriptions of pig iron will serve. It is understood, however, that large tonnages of high-grade ore have arrived in this country from North Africa, and it follows that a welcome increase in the production of hematite and special pig irons will result. Hematite pig iron has long been in urgent request, particularly by the heavy engineering foundries which have had to make do with substitutes and which have shown great adaptability in the use of these alternatives. The possibility of using hematite pig iron on a wider scale will be welcomed by these establishments. The position of low-phosphoric and refined irons is much the same as hematite, and users of these descriptions are anticipating relief from increased outputs now that the ore is available. As in the case of hematite, the Control has had to exercise caution in the distribution of these descriptions, and it is probable that it will adopt a careful policy in increasing supplies, but there is no doubt that the consuming industries have been greatly cheered by the news of the renewal of the ore traffic from North Africa. Ample supplies of high-phosphoric pig iron are available, and these are passing into consumption in considerable quantities. The largest consumers of high-phosphoric iron are the light castings foundries, and although the position in this industry has improved, only a minority are really busy. The restriction of domestic light castings has greatly affected this trade during the war, and although in some cases foundries have been able to adapt their plant to the production of the castings required by engineering firms engaged on war work, the incorporation of the light castings industry in the war effort has been only partial. The production of basic pig iron for the steel works is on a heavy scale, and there seems little likelihood that any stringency will develop in this department. Good supplies of forged iron are available for consumers.

Scotland and the North

The consuming industries in Scotland are working full pressure, chiefly on war work, and the demand for all descriptions of iron and steel is sufficient to keep the producing works operating at capacity. The shipyards have a big programme of construction in hand and are requiring large quantities of plates. In addition to the pressure from the shipyards, the tank makers, locomotive and wagon builders are also big consumers, so that the pressure upon the steel works producing plates is unrelaxed. Most of the works have big order books for delivery in the third period. There is a steady and increasing demand for the lighter descriptions of structural steel and delivery dates continue to lengthen. On the other hand, the demand for heavy joists and sections is poor and orders for fairly near delivery can be placed without much difficulty. The delivery position has been eased somewhat by the Control distributing to consumers parcels of joists and sections from stock. The sheet industry is fully employed and the orders in hand will keep the works busy for the whole of Period III. Large tonnages of sheets are required by the shipbuilding industry, and Service requirements are on a heavy scale. The volume of business coming forward has declined recently, but with the works well provided with orders the immediate situation is not likely to be affected. Great activity rules in the Lancashire steel market and the steel industry is working under heavy pressure. There is a big demand for alloy steel and recently there has been a sharp demand for nickel steel. The heavy electrical and general engineers continue to use big tonnages of plates, although their requirements are not on such a heavy scale as those of the shipyards. Steel bars are in strong request and the demand for large diameter bars, which has lasted some time, has made the position rather tight. A big business is also passing in bright-drawn and turned bars. The production at the steel works on the North-West Coast is on a heavy scale, and there is a big output of billets, structural steel, plates, and bars.

Midlands and South Wales

The Welsh iron and steel makers can see no likelihood of any relaxation of the pressure of demand which has lasted for so long. Most of the works have large order books for delivery over the third period, and orders have been taken for delivery in the last quarter of the year. The demand for heavy joists seems to be gradually declining, but there is no decrease in the demand for light joists sections, and other descriptions of light structural material. The arrangements which have been instituted by the control for providing re-rolling establishments in the Midlands with regular weekly quantities of semis have relieved the position. Previously, consumers had been kept in uncertainty as to the quantities of semis that would be delivered, and had difficulty in maintaining a regular programme. There is an active request from this section of the industry for defective billets, and any kind of raw material which is suitable for use in the re-rolling works. The situation in the plate department is unaltered, and the whole of the production passes into immediate consumption. A large proportion of the orders now on the books of the producing works are for delivery in Period III. The pressure of the demand, as has been the case for a long time, comes from the shipyards, tank makers, and boiler makers. Although the volume of new business in sheets has declined in recent weeks it has had little effect upon the situation, as the works have orders in hand sufficient to keep them busy during the whole of Period III. The decline in the demand has been less in light and heavy sheets than sheets of medium thickness. The iron and steel works in South Wales are fully employed. The finishing departments are operating at capacity, and there is an insistent call for all descriptions of shipbuilding material. The raw materials position is satisfactory, and the increased production of semis, billets, and sheet bars, coupled with larger imports from the United States, has relieved any anxiety on the part of the re-rollers. The situation of the tinplate industry cannot be called satisfactory, but this industry is suffering largely from necessary war restrictions. However, there has been an improved business in the home market, and more orders for export have been received.

North-East Coast and Yorkshire

Capacity working is the rule rather than the exception at the steel works on the North-East Coast. There is little doubt that the tonnage of uncompleted orders at the end of Period II will be comparatively small. No relaxation is apparent in the demand and some of the works have a big tonnage of orders in hand for delivery in Period III. The semis position has greatly improved and the re-rollers have little fear that a stringency will develop. The re-rolling works are turning out important quantities of light structural steel, bars, plates, and sheets, largely to meet Government needs. There is an insistent demand for plates, and consumers have little chance of finding a works able to give delivery before the middle of Period III, and in many cases not until Period IV. Most consumers, probably, will find that they will be unable to secure delivery before the last period of the year. The shipyards are taking the largest quantities and the amount of prefabricated work in hand has increased their requirements. The tank makers, boilermakers, and engineering establishments are also taking up large tonnages. The volume of business in structural steel is considerable, but the demand is principally for the lighter sizes. Orders for the heavier can be placed without much difficulty for fairly near delivery. The active call for the lighter sections is keeping the producing works fully employed, and there is a tendency for delivery dates to lengthen, although this is not a prominent factor of the market. The sheet industry is fully engaged, but recently there has been a noticeable decline in the amount of fresh business coming forward. The demand for heavy sheets has not diminished so much, as these are being taken in considerable quantities by the shipyards and for the manufacture of railway equipment. Great activity rules in nearly all sections of the Yorkshire steel industry. Most of the works have considerable tonnages on order for delivery in the third quarter. Producers of basic steel are operating under great pressure. Fortunately, the raw material position is satisfactory, and from this point of view the production should be well maintained. There is a strong request for acid carbon steel, and the whole output is going almost immediately into consumption. There is still an active call for alloyed steel, which is required in considerable quantities by the armament makers.

Iron and Steel Scrap

On the whole, the scrap position is comfortable, but the authorities continue to impress upon the country the need at this stage of the war for the maintenance of supplies of all descriptions of scrap. The position, however, is not uniform, and the descriptions that the steel works are most anxious to obtain are those in the smallest supply. It is pointed out that future collections of old scrap will be less successful than those in the past, since already large quantities of materials which may be regarded as reserves have been taken. Business in the scrap market generally has been more active of late, particularly in the higher-quality kinds. The steel works have shown an inclination to take up as much of this class of material as possible in order to cover their requirements for the next three months. Good heavy mild steel scrap, cut to furnace and foundry sizes, seems to be in rather tight supply. There is also a fair volume of business passing in bundled steel scrap and hydraulically compressed steel shearings. The demand for this description is steady and consumers are obtaining their full requirements. Mild steel turnings, which a few weeks ago were in liberal supply, appear to have become rather scarce and the demand, in consequence, has become more noticeable. Mixed wrought iron and steel scrap for basic furnaces is in better demand. There is not an abundant supply of heavy material, but light material is plentiful and stocks of this sort are accumulating. Consumers who are short of heavy scrap material are more active in buying compressed basic bundles. Many of the acid steel furnaces have built up stocks of alloy steel and there is a moderate demand for nickel steel scrap. Short heavy steel scrap is being sought by the steel foundries and electric furnaces. There is a strong demand for heavy cast iron in large pieces and furnace sizes, but the business passing is restricted by the small quantities which are coming forward. Business is quiet also in light cast iron scrap, as, although there seems to be a fair demand, the quantities available are not large.

TIMBER REPLACES STEEL.—The latest adaptation of timber to construction in the U.S.A. is a prefabricated plywood and timber *I*-beam, which will be known to the trade as a "Timbeam." It is an I-shaped plate girder built up either solid or laminated. Used as a beam, it is available in sizes suitable for clear spans up to 60ft., and columns up to 35ft. high are also available. They are being used in building and bridge construction, and load tables, based on extreme fibre stress of 1200 lb. per square inch, are available for design and structural engineers. The ends of "Timbeam" are tied with a diagonal tie from bottom to top flange because of the greater tension and shear stresses at these points which the thin plywood web could not resist alone. Flange and web members are glued together and dowelled with maple dowels.

Notes and Memoranda

Rail and Road

RAILWAY PROGRESS IN TURKEY.—A recent report from *The Times* correspondent in Turkey shows that in spite of difficulties caused by the war, the construction of railway lines linking Turkey to Persia and Iraq is still going on. A bridge, more than a quarter of a mile long, over the River Batman, has just been completed, and the line up to Batman Station was officially opened last week-end.

LINKING UP WITH ALCAN.—An indication of the importance attached to the Alaska Highway is shown in the announcement that four parties of B.C. Government surveyors are being organised to hasten the selection of the most feasible route by which Prince George can be joined to Dawson Creek or some other convenient point on Alcan Highway. It is expected the work will run to 7 or 8 million dollars. This is extra and beyond the general plan of expenditure of 15 million dollars on extension of the general highway system of the province.

NEW MEXICAN ROAD.—A statement by the Director-General of Highways in Mexico, referred to in a recent issue of *Railway Gazette*, reveals that a new 424-mile highway, which will connect the Mexican cities of Torreon and Durange with the Pacific port of Mazatlan, is now nearing completion. Torreon is an important railway junction on the central plateau region, in the middle of a rich cattle and agricultural region and about halfway between the Atlantic and Pacific oceans. The town of Durango is almost in the centre of the state of the same name, and this region has substantial agricultural and mineral resources. Mazatlan is on the Pacific Ocean near the southern end of the Gulf of Lower California, and has an excellent deep-water harbour. It is on the main west coast railway between the U.S.A. and Mexico City. There is already a standard gauge railway between Torreon and Durango, but only part of the rail extension thence to Mazatlan has yet been built.

CENTRALISED TRAFFIC CONTROL.—The Chicago, Burlington and Quincy Railroad has recently installed centralised traffic control on a 39·9-mile single-track section of line between Aurora, Ill., and Steward Junction, on its Chicago and St. Paul main line. The line from Chicago to Aurora, 37·7 miles, is multiple track to accommodate local as well as through traffic. At Aurora the railway divides, a double-track main line extending westward toward Omaha and Denver, and another main line extending north-west through Savanna, Ill., to St. Paul, Minn., 427 miles from Chicago. Between Aurora and Steward Junction, 39·9 miles, this St. Paul line is single track, beyond which 8·5 miles of double track extends to Flag Centre. This latter section is used also by trains of the Chicago, Milwaukee, St. Paul and Pacific, and was equipped with centralised traffic control in 1929, the signalling being arranged for train movements in either direction on both tracks. This centralised traffic control territory is operated from a machine at Rochelle, Ill., which is about midway in the territory. West of Flag Centre the line is single track for 59 miles to Savanna, beyond which point double track extends for 282 miles to St. Paul.

Air and Water

AMERICAN MERCHANT NAVY.—The 1651st new ship built for the American merchant navy since the United States entered the war has been launched at Baltimore. She is a "Liberty" ship of 10,500 tons.

TAY BRIDGE SCHEME.—A three-million-pound scheme for the construction of a road bridge across the River Tay at Dundee has been rejected by the Government. In making known this decision to the Corporation, the Lord Provost of Dundee said that the Ministry of War Transport had intimated that important developments in the road system of the country were having consideration.

THE MOTORSHIP "SUECIA."—The Lindholmen shipyard of Göteborg has recently launched a motor liner of 7400 tons deadweight, the motorship "Suecia," for the Swedish Johnson Line. A feature of the ship is that she will be equipped with a reversible and adjustable propeller, and she is the biggest ocean-going vessel so far to be provided with a propeller of this kind. The propeller will be of the Swedish "Kamewa" type, a number of Swedish tugs, minesweepers, auxiliary vessels, &c., having in recent years been equipped with propellers of that type with satisfactory results. The "Suecia" is a combined cargo and passenger carrier and is a sister ship of the "Argentina," already delivered to the Johnson Line by Götaverken. The propelling machinery, which will be installed by the builders, develops 8600 I.H.P. and is estimated to give the vessel a speed of 17 knots fully loaded.

TRANS-TASMAN AIR LINES.—During the period from April, 1940—when the Trans-Tasman service between Auckland and Sydney was begun—and December, 1942, Tasman Empire Airways flew 6,752,260 passenger-miles, carried 112,713 lb. of freight, and 326,215 lb. of mail. *The Aeroplane* says that of 404 flights scheduled, 394 were flown. A total of 5095 passengers were carried, 527,760 miles were flown, and flying hours amounted to 3489.

TIMBER HANGAR FOR AIRSHIPS.—The engineers of the U.S. Navy claim to have built the world's largest timber structure. It is now nearing completion "somewhere in the Continental United States." Its timber arches rise 153ft. from the floor, clear-spanning an unobstructed area 237ft. wide and 1000ft. long. It will be used for housing airships. Had it not been built of wood, a total of 2050 tons of structural steel would have been required.

NEW SWEDISH MOTOR LINER.—It is reported from Stockholm that the motor liner "Mangalore," launched by the Götaverken yard some months ago for the Swedish East Asiatic Company, has completed its trial trip. The "Mangalore" is 425ft. long with a beam of 57ft., and is 7420 tons deadweight. Machinery consists of an eight-cylinder, single-acting, two-stroke oil engine of the latest Götaverken design, developing 6400 I.H.P. at 102 r.p.m. The "Mangalore" is the tenth ship constructed by Götaverken for these owners.

TESTING OF STRATOSPHERE AIRCRAFT.—For testing on the ground mechanical parts of aircraft and radio equipment used at high altitudes, the Kold-Hold Manufacturing Company, Lansing, U.S.A., has built a stratosphere chamber that operates at temperatures between 200 deg. Fah. above zero to 75 deg. Fah. below zero, and at varying internal pressures; 245 cubic feet interior. Refrigeration is effected by forced convection through coils designed for low-temperature work. *Machinery* says that with it data may be obtained in a few hours that it would take days to record with former methods.

Miscellanea

THE USES OF STEEL DRUMS.—American engineers in and out of the Army are finding so many fresh uses for empty steel drums, barrels, and pails that the appropriate authority has revised the definition of "used drum" to bring drums of 5 U.S. gallons within the scope of the Order. It also permits a supplier of goods, as well as a manufacturer, to apply for an extension of the time he is permitted to retain an empty used drum. Too many of these receptacles were being utilised for roofing material, water pipes, and other purposes.

INDIA MAKING ALUMINIUM.—Hitherto India has made some at least of her aluminium requirements from imported sheets, although it was known that large deposits of bauxite were available in the country. Now, virgin aluminium has been produced for the first time in India by the Aluminium Production Company of India, Ltd., whose reduction works are situated in South India. The same company early in 1941 completed the construction of up-to-date aluminium rolling mills near Calcutta.

COMPRESSED AIR SOLVES TWO PROBLEMS.—In a United States war plant, use of compressed air has solved two annoying production problems. In the process of making self-locking speed nuts and similar products from metal strip, a means had to be found to separate long strips of paper that are rolled up with the strips of stainless steel. When the stainless steel was fed into the die presses there was no convenient way of discarding the paper. The trouble was overcome in this way:—As the metal is fed off the roll into the die stamping machine the end of the paper is fed into the "barrel" of a gun made of 3in. pipe about 2ft. long, into which is inserted the open end of a pipe about 1in. in diameter, carrying compressed air. The air pressure keeps feeding the paper through the gun barrel. As the paper travels through it falls into a waste paper basket. The other problem was the separation of the speed nuts after they are lacquered. The lacquer is sprayed on to the nuts inside a revolving barrel, and in the course of drying many of the small, light pieces of metal adhere. Separation of these was a time-consuming job, so a gun similar to the other was devised. It has a "barrel" of about the same size with the outlet of the compressed air pipe, in this instance, a few inches from the mouth of the gun barrel. The nuts are dumped on to a tray on top of the apparatus and are permitted to drop, a few at a time, into the air stream. They are immediately blown through the gun by the air current at approximately 90 lb. per square inch pressure and shot against a heavy wire screen at the other end of the apparatus, where they break apart and fall into a basket.

SCRAPPING A VETERAN.—An American war undertaking, organised to rebuild or scrap machinery, has just dismantled what is thought to be the largest single unit yet turned over to it as scrap. It was a coal stripping shovel, which was once a famous machine. To-day, its steam boiler is destined for more years of service in a war plant, while its steel will be used as scrap to make war materials. Costing over 100,000 dollars when new, this 6-yard shovel, weighing over 300 tons, is now rated as a small shovel in the United States coal strip-mining business, where dippers as large as 36 yards are in use.

PARLIAMENTARY AND SCIENTIFIC COMMITTEE.—The Lord President of the Council, Sir John Anderson, and the Minister of Fuel, Major Lloyd George, received on Tuesday, June 29th, a deputation from the Parliamentary and Scientific Committee, which urged the Government to carry out the recommendations in the Committee's recent report on the potentialities of coal in creating new industries for Britain and expanding old ones. The deputation, it is reported, came away convinced that the Government is thinking on the same lines as the Committee about the fundamental importance of scientific research to the future of industry; that where a good case can be made out for any specific research project they can look forward with confidence to action being taken; and that in a few months' time when another deputation from the Committee is to be received the Government will be able to report all possible progress considering the present overriding war demands on men and materials.

Personal and Business

MR. DANIEL SHARPE has been elected President of the Institute of British Foundrymen.

DR. W. E. LE B. DIAMOND, assistant secretary of the Institution of Gas Engineers since 1937, has been appointed general manager of the British Plastics Federation.

MR. ARTHUR GOUGE, B.Sc., F.R.Ae.S., has been elected President of the Royal Aeronautical Society for the year October, 1943, to September, 1944. Dr. H. Roxbee Cox, Ph.D., D.I.C., B.Sc., F.R.Ae.S., and Mr. E. F. Relf, F.R.S., F.R.Ae.S., have been elected Vice-Presidents of the Society for the same period. These elections are all for second terms of office.

MR. W. J. MARSHALL, technical manager of Aveling-Barford, Ltd., Grantham, is retiring from active participation in the business after many years' service. His services are being retained in a consultative and advisory capacity. No new appointment will be made, and Mr. O. S. Penn will in future be responsible for all technical matters, assisted by Mr. C. W. Wilcock, who now becomes assistant chief engineer.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institute of Physics

Saturday, July 10th.—Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. Discussion opened by D. E. Thomas. 2.30 p.m.

Institution of Automobile Engineers

Tuesday, July 6th.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. Debate to be opened by C. Kimber. 6.15 p.m.

Institution of Electrical Engineers

Saturday, July 10th.—LONDON STUDENTS' SECTION: Visit to Johnson and Phillips, Ltd. 2.30 p.m.

Royal Aeronautical Society

Wednesday, July 14th.—GRADUATES' SECTION: 4, Hamilton Place, W.1. "Surface Finishing of Components," J. A. Oates. 7.30 p.m.

Union des Ingenieurs et Techniciens de la France Combattante

To-day, July 2nd.—Inst. of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. Conference on "The Reconstruction of French Industry," Commander H. Bernard. 5 p.m.